



Invasive Plant Management in Kenai Fjords National Park

2013 Summary Report

Natural Resource Data Series NPS/KEFJ/NRDS—2014/636



ON THE COVER

From top left moving clockwise: Fireweed blooms along the Harding Icefield Trail; SAGA crews and EPMT staff control invasive plants at the NPS maintenance facilities; a young common dandelion in bud shows its recurved involucre bracts; meadow foxtail in anthesis; SCA Intern Nara McCray maps common dandelion at Dingelstadt Glacier in McCarty Fjord. Photographs by: Peter Frank/NPS

Invasive Plant Management in Kenai Fjords National Park

2013 Summary Report

Natural Resource Data Series NPS/KEFJ/NRDS—2014/636

Peter A. Frank

National Park Service
Kenai Fjords National Park
411 Washington Street / PO Box 1727
Seward, Alaska 99664

March 2014

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Frank, P. 2014. Invasive plant management in Kenai Fjords National Park: 2013 summary report. Natural Resource Data Series NPS/KEFJ/NRDS—2014/636. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	v
Tables.....	vii
Appendices.....	vii
Abstract.....	ix
Acknowledgments.....	xi
Acronyms.....	xi
Introduction.....	1
Methods.....	4
Defining 2013 Project Areas	5
Prioritizing Treatments	5
Tools for Identification and Data Collection	5
Control Methods	6
Personnel.....	6
Results.....	7
2013 Season Overview	7
Exit Glacier Area	9
<i>Herman Leirer Road</i>	9
<i>Exit Glacier Parking Lot</i>	11
<i>Campground</i>	11
<i>Employee Housing</i>	11
<i>Nature Center Plaza and Main Trail</i>	12
<i>Trail to the Glacier View</i>	12
<i>Trail to the Edge of the Glacier</i>	12

Contents (continued)

	Page
<i>Harding Icefield Trail</i>	13
<i>Nike Stripe</i>	14
<i>Outwash Plain</i>	14
<i>New Survey Sites</i>	15
Seward	16
<i>Maintenance Facilities</i>	16
<i>Information Center</i>	16
Coastal Areas	16
<i>Aialik Bay</i>	16
<i>McCarty Fjord</i>	18
<i>Nuka Bay</i>	18
Outreach and Education	19
Gypsy Moth Monitoring	20
Discussion & Recommendations	21
Location Specific Recommendations	21
<i>Exit Glacier Area</i>	21
<i>Seward</i>	23
Coastal Areas	23
Data Collection	24
Outreach and Education	24
Seed Collection	25
Literature Cited	27

Figures

	Page
Figure 1: Reference map of Kenai Fjords National Park.....	3
Figure 2: Dense stands of common dandelion found along Herman Leirer Road	9
Figure 3: White clover found growing along the Herman Leirer Road.....	10
Figure 4: Road construction along Herman Leirer Road.....	10
Figure 5: Alpine timothy (<i>Phleum alpinum</i>), seen here on the right, is a common native species found in the Exit Glacier parking lot, which can be confused with its exotic counterpart common timothy seen here on the left.....	11
Figure 6: Four years of continued control has significantly reduced the density and extent of annual bluegrass along the Trail to the Glacier View allowing native grasses to move into the trail margins.	13
Figure 7: EPMT and SAGA crew pose for a photo in Marmot Meadows	14
Figure 8: EPMT crew member sprays herbicide on a small patch of common dandelion at the Nike Stripe.	14
Figure 9: NPS staff spray common dandelion on the outwash plain.....	15
Figure 10: Crew members cross Exit Creek during the 2013 scouting surveys on the outwash plain.	15
Figure 11: SAGA crew member expresses her feeling about invasive species.	16
Figure 12: NPS staff members identify an unknown dock species on the beach of Aialik PUC.....	17
Figure 13: Crew members disembark to survey the camping beach in Abra Cove in Aialik Bay.	17
Figure 14: SCA intern Nara McCray maps a patch of common dandelion near Dinglestadt Glacier in McCarty Fjord.....	18
Figure 15: NPS Bio. Tech. Peter Frank determines the location of a previously mapped infestation in Beauty Bay.....	18
Figure 16: Volunteers pose for a group photo during the 2013 Herman Leirer Road community weed pull.....	19
Figure 17: EPMT staff hangs a gypsy moth trap in the Exit Glacier area.	20

Tables

	Page
Table 1. Summary of Kenai Fjords National Park Exotic Plant Management Work.	7
Table 2: Invasive plant species observed in and around Kenai Fjords National Park.	8

Appendices

	Page
Appendix A: Change in Gross Acreage of Invasive Plants in KEFJ (2010-2013).....	29
Appendix B: Prioritization of Invasive Species.....	31
Appendix C: Site Specific Maps.....	33
Appendix D: Gypsy Moth Monitoring Trap Locations	43

Abstract

This report describes the work performed by the Exotic Plant Management Team (EPMT) at Kenai Fjords National Park (KEFJ) during the 2013 field season. This summer marked the tenth consecutive year that KEFJ staff have monitored and controlled invasive plants in accordance with the Alaska Exotic Plant Management Team protocol. In 2013 the KEFJ EPMT focused on two primary objectives. The first objective was to control all existing infestations found within the park in order to reduce their overall extent and prevent their further spread. The second objective was to accurately document the distribution and abundance of invasive species found within the park to facilitate future management decision making. The 2013 KEFJ EPMT staff, which consisted of one Biological Science Technician, one Student Conservation Association intern, one Biological Aid and one Youth Conservation Corps intern, devoted approximately 1,394 hours toward managing invasive species found in and around the park. EPMT staff surveyed a total of 13.4 acres during the 2013 field season, of which a total of 3.4 acres were found to be infested. This marked the lowest overall infested acreage documented in KEFJ in three years, suggesting that focused and diligent control work may be beginning to show its effectiveness. Of the 3.4 acres found to be infested, a total of 3.2 acres were treated by means of manual and chemical control. Survey and control work in KEFJ was focused in the Exit Glacier area, with particular emphasis put on the trail system, campground, employee housing area and the parking lot. In total, 14 invasive species were documented, within the park in 2013. No new species were documented but one reoccurring species, meadow foxtail (*Alopecurus pratensis*), was documented and controlled in the park for the first time since 2010. Additionally, two multiday trips to the coastal regions of KEFJ allowed EPMT staff to survey a total of 14 coastal sites, treat three known infestations, and document and control two infestations found for the first time in 2013. Future EPMT staff at KEFJ should continue to monitor and control all infestations found in the park, focusing on the eradication of infestations of high priority species found in areas of limited disturbance.

Acknowledgments

The author would like to thank all the individuals who have dedicated their time and energy to make the 2013 Kenai Fjords National Park Exotic Plant Management Team's season a success; Christina Kriedeman, whose guidance, support and extensive experience were invaluable over the course of the season; SCA Intern Nara McCray, Biological Aid Hannah Beutler and Youth Conservation Corps Member Miles Knotek for their continued enthusiasm and diligence during the 2013 field season; Chris Overbaugh and Tim Federal for their overall expertise and assistance in all aspects of the program; Mark Kansteiner for his technical and logistical support; as well as park staff members Travis Fulton and Mark Stokstadt and park volunteer Ann Fineman for their help in monitoring invasive plants in the Exit Glacier Area.

The author would also like to acknowledge those who have so generously volunteered their time to benefit the Exotic Plant Management Team this summer; the Southeast Alaska Guidance Association crew, whose hard work helped to meet and exceed treatment objectives in the Exit Glacier area. All the volunteers who helped make the 2013 Herman Leirer Road Community Weed Pull successful; the Chugach National Forest's Student Conservation Association crew, the Resurrection Bay Conservation Alliance, Alaska Association of Conservation Districts Invasive Plant Coordinator Jen Kain, Sharon Kim, Julie Markus and all other Kenai Fjords employees that showed their support during this event.

Acronyms

AACD Alaska Association of Conservation Districts	NPS National Park Service
AKNHP Alaska's Natural Heritage Program	PUC Public Use Cabin
EPMT Exotic Plant Management Team	RBCA Resurrection Bay Conservation Alliance
GIS Geographic Information System	SAGA Southeast Alaska Guidance Association
GPS Global Positioning System	SCA Student Conservation Association
HIT Harding Icefield Trail	USFS United States Forest Service
KEFJ Kenai Fjords National Park	YCC Youth Conservation Corps
M/V Marine Vessel	

Introduction

Kenai Fjords National Park (KEFJ), located along the southeastern coast of the Kenai Peninsula, is an expansive, geologically young and dynamic glacial fjord system. The park is dominated by the Harding Icefield, which at approximately 689 square miles covers more than 50% of the park's land area. More than 38 glaciers associated with the Harding Icefield flow down through the park from the Kenai Mountains to the Pacific Ocean. These glaciers have sculpted the park landscape and their retreat over time has helped to form the multitude of unique ecosystems found in KEFJ.

Several characteristics make KEFJ vulnerable to the introduction and spread of invasive plants. The glacial characteristics, described above, have created an abundance of natural disturbance throughout the park and create ecological niches for invasive plants to establish and spread. The threat of invasive plant introduction to KEFJ is compounded by the ever-increasing anthropogenic influence in the park. Two human activities are responsible for the majority of new invasive plant introductions to KEFJ. The first is the annual influxes of visitors, researchers and staff, who by various means unintentionally transport invasive plant material into the park or translocate invasive plant materials within the park. The second is the ongoing maintenance activities associated with the infrastructure for visitation in the park that disturb native plant communities and facilitate the introduction and establishment of invasive species.

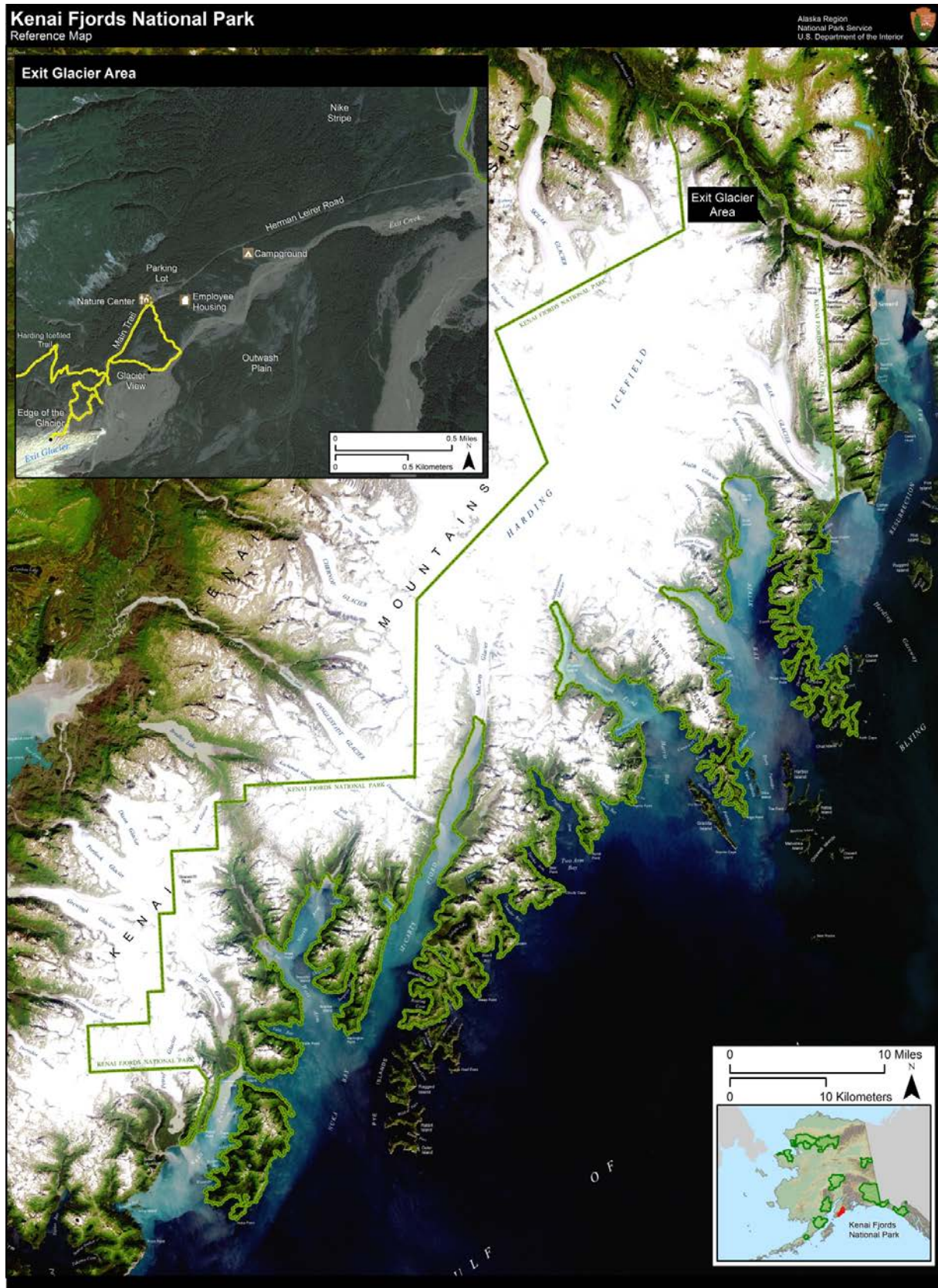
The park can be divided into two primary use areas, the Exit Glacier area and the coastal fjords. Each area and its adjacent lands are distinctive in their visitor use, terrain, and ecology as well as their vectors for invasive plant introduction, necessitating a unique exotic plant management strategy for each location. The Exit Glacier area is the only part of the park that can be accessed by road and therefore has been the focus of visitor development in the KEFJ. Given its accessibility, the Exit Glacier area is the most visited location in the park, receiving over 100,000 visitors annually. Heavy use has led to the introduction and spread of invasive species in the Exit Glacier area, so much so that this area contains the largest and most diverse infestations found in the park. The coastal areas of the park are a system of rugged, glacially carved fjords. The majority of people that visit these coastal fjords do so in tour boats and never step foot onto land. Only a relatively small number of visitors as well as park staff and researchers have the opportunity to explore these coastal areas, which limit the vectors of invasive species introductions. Despite the logistical hindrance to introduction, small and isolated infestations are still found along the coast in areas of human use, highlighting the need for continued monitoring in the coastal areas of KEFJ.

The Alaska Exotic Plant Management Team (EPMT) has had staff members inventorying and controlling invasive plants in KEFJ since 2004. Over the past ten years EPMT staff members have gathered baseline data on the extent of invasive plants in the area, conducted annual monitoring surveys, established community outreach events, honed prevention methods and controlled infestations found in and around the park. The KEFJ EPMT has focused on early detection and eradication of high-priority infestations found within the park. This early response approach to emerging infestations, coupled with steady and focused control on all infestations found in the park, has helped to minimize the extent of invasive species in KEFJ. Compared to the other seven NPS units in Alaska with EPMT programs, only the remote Yukon - Charley

Rivers National Preserve has fewer documented exotic species and fewer infested acres than KEFJ. Thus, KEFJ has the unique opportunity to manage or eradicate many of their exotic plant infestations before they become a more serious ecological and economic problem. In order to accomplish this, monitoring efforts, prevention strategies and aggressive control have been put into effect within the park.

In 2013, the KEFJ EPMT continued annual inventory and monitoring efforts and collected high-quality geospatial data conveying the distribution, abundance and species composition of invasive plants within the park. EPMT staff revisited all known infestations in KEFJ during the 2013 field season. Invasive plant control activities were focused on aggressively treating small and disjunct infestations and containing large populations that threaten to expand their extent within the park. Education and outreach activities targeted park staff and visitors seeking to better inform them of the threats non-native species pose to native ecosystems. The data gathered in 2013 will be used to prioritize future work in the park and formulate long-term monitoring and control goals.

This report details the status of invasive plants in KEFJ and draws conclusions on best management practices for the future of invasive plant management in the park.



Methods

EPMT fieldwork at KEFJ occurred between June 4th and September 6th, 2013. Methods of mapping and data collection followed the protocol developed by the Alaska Region Exotic Plant Management Team (Million et al. 2013). The KEFJ EPMT staff utilized existing data as well as recommendations from the previous years, adapted for this season's phenology and available labor, to prioritize infestations and species for control and select appropriate control methods.

Defining 2013 Project Areas

To facilitate the planning of control efforts, the park and its environs were divided into three project areas; the Exit Glacier area, Seward and Coastal areas. These three project areas were further subdivided into work areas based on geographic location as well as their extent and abundance of invasive species. Fieldwork was organized and conducted using these classifications, therefore the results, recommendations and maps in this report are structured around these project area and work areas.

The three project areas and their work areas include:

<u>Exit Glacier Area</u>		<u>Seward</u>	<u>Coastal Areas</u>
1. Herman Leirer Road	6. Trail to the Glacier View	1. Maintenance Facility	1. Aialik Bay
2. Exit Glacier Parking Lot	7. Trail to the Edge of the Glacier	2. Information Center	2. McCarty Fjord
3. Campground	8. Harding Icefield Trail		3. Nuka Bay
4. Employee Housing	9. Nike Stripe		
5. Nature Center Plaza and Main Trail	10. Outwash Plain		

Prioritizing Treatments

Control work in KEFJ was prioritized based on the geographical location, extent and invasiveness ranking of the plant in question. The invasiveness rank is a 1 to 100 scale, in which higher scores denote greater invasiveness. Rankings are assigned to each invasive species by assessing four criteria: potential impacts to ecosystems, biological attributes, distribution, and effectiveness of control measures (Carlson et al. 2008). Species with higher invasiveness rankings and smaller extents were considered the highest priority for management. Conversely, species with low invasiveness rankings and larger extents were considered the lowest priority. Prioritization was further refined by geographic location as infestations growing in undeveloped backcountry areas of the park were targeted as a higher priority than those infestations limited to the frontcountry areas in and around the park.

Tools for Identification and Data Collection

The primary field guides referenced for plant identification were *The Flora of South Central Alaska* (Shaffer 2000), *Plants of the Pacific Northwest Coast* (Pojar and Mackinnon 1994) and *A Field Guide to Alaska Grasses* (Skinner et al. 2012). The *Flora of Alaska and Neighboring Territories* (Hulten 1968) was used to confirm plant identification. Detailed information on the biology, invasiveness potential, ecological impacts and distribution of various invasive plants were obtained from the Alaska Natural Heritage Program (AKNHP 2013). Spatial data on invasive plant infestations were collected using two Trimble GeoXT data loggers; on occasions where higher levels of precision were required a Trimble Zephyr antenna was also utilized. Each

of these units were set to collect data only when accuracies were below five meters in compliance with the 2013 Alaska Exotic Plant Management Team field protocol (Million et al. 2013). Trimble Pathfinder Office 5.40 was used to differentially correct and edit the GPS data. The Continuously Operating Reference Stations (CORS) used during differential correction in 2013 were; CORS Soldotna, AK 2007 and CORS Kenai 5.

Post-processed data were sent to the Alaska EPMT Liaison for entry into the National Park Service's Alien Plant Control and Management (APCAM) database every two weeks. The regional EPMT staff converted the GPS data to ArcMap feature classes to be implemented into the Alaska Regional invasive plant geodatabase for use in future KEFJ GIS projects.

Control Methods

Manual removal techniques such as hand pulling or digging were the primary control methods employed for invasive plant removal. These methods allowed for selective control without the use of chemicals. Another form of manual control utilized on large perennial infestations, where pulling or digging is no longer feasible, was the removal of flowers prior to seed production. Though this method does not reduce the size of infestations it may help curb the spread of species that propagate through seed dispersal.

All removed invasive plant material was bagged and weighed on site using a small hanging scale and transported to the Seward Transfer Facility for disposal in a land fill. This method minimized the potential for seed dispersal while disposing of the invasive plant material. Care was also taken to ensure that bags used in Seward or the Exit Glacier front country were not reused outside of these areas due to the potential for seed dispersal.

Chemical control was utilized by the 2013 EPMT staff in accordance with the Alaska Regions Invasive Plant Management Plan Environmental Assessment (NPS 2009). Chemical herbicides have been utilized in KEFJ since 2011 to control large, outlying and high priority infestations of common dandelion (*Taraxacum officinale*) which have not responded to manual treatment. The herbicide Milestone, which is a broadleaf specific herbicide that contains the active ingredient aminopyralid, was selected for use in KEFJ. During chemical treatments an herbicide solution, containing 6ml of Milestone per gallon of water, was applied to individual plants by spot spraying. All herbicide operations were performed by crew members who had received training and earned certification as State of Alaska Licensed Pesticide Applicators.

Personnel

The core members of the 2013 KEFJ EPMT were; Peter Frank a NPS GS-5 Biological Science Technician; Nara McCray a Student Conservation Association (SCA) intern; Hannah Beutler a NPS GS-1 Biological Aid; and Miles Knotek, a Youth Conservation Corps (YCC) intern. Two KEFJ staff members and two Alaska regional EPMT staff members assisted in the herbicide operations conducted in the park in 2013. A number of other KEFJ staff members helped during a volunteer event and as needed based on availability and experiential knowledge. A six person volunteer crew of Southeast Alaska Guidance Association (SAGA) AmeriCorps members assisted the KEFJ EPMT with large scale invasive plant control efforts for two consecutive weeks between July 22th and August 9th.

Results

2013 Season Overview

The 2013 KEFJ EPMT staff surveyed 13.4 acres within the park of which 3.4 acres were found to be infested. EPMT staff treated 3.2 infested acres within the park this summer; of which 2.11 infested acres were manually controlled resulting in the removal of 730 pounds of invasive plant material, and the remaining 1.09 infested acres were chemically controlled during which 32.75 gallons of mixed herbicide containing 6.6 ounces of concentrate were applied. A total of 1,394 person-hours were logged by the EPMT staff this season while performing activities associated with the program. EPMT staff and volunteers spent a total of 838 hours in the field performing activities including surveying for, mapping and controlling invasive plant species. Survey work during 2013 resulted in the documentation of 14 invasive plant species including one reoccurring species; meadow foxtail (*Alopecurus pratensis*), which has not been documented in the park since 2010. Two previously undetected coastal infestations; annual bluegrass and common plantain at Abra Cove in Aialik Bay as well as common dandelion on the beach at the head of North Arm in Nuka Bay; were documented and controlled in 2013. Mapping efforts in 2013 improved the resolution of data on the distribution and abundance of non-native species particularly in the Exit Glacier area along the Harding Icefield Trail (HIT) and in the parking lot. Control work was focused on the Exit Glacier area, as 3.15 of the 3.2 acres treated in the park in 2013 were within the Exit Glacier area. Tables 1 and 2 summarize EPMT work conducted in 2013. Changes in gross species acres between 2010 and 2013 are summarized graphically in Appendix A. Site specific maps, which visually summarize the results discussed below, can be found in Appendix C.

Table 1. Summary of Kenai Fjords National Park Exotic Plant Management Work.

Year	Invasive GPS Data NPS Lands (non-NPS lands)		
	Species Acres Surveyed	Species Acres Infested*	Acres Treated
2004	2.8 (0.5)	1.7 (0.5)	0.5 (0.5)
2005	9.7 (0.1)	2.8 (0.01)	2.3 (0.01)
2006	42.7 (0.3)	5.4 (0.3)	4.8 (0.2)
2007	23.5 (1.8)	5.2 (0.01)	1.9 (0.01)
2008	24.0 (0.2)	3.4 (0)	1.7 (0)
2009	26.1 (3.2)	2.7 (0.01)	2.3 (0.01)
2010	55.9 (5.9)	5.5 (0.01)	3.4 (0.01)
2011	27.6 (9.3)	7.5 (0.8)	6.1 (0.8)
2012	21.4 (5.5)	7.1 (0.2)	5.5 (0.2)
2013	13.4 (0.4)	3.4 (0.1)	3.2 (0.1)

* All acreage was calculated using January 2012 NPS land status. Acres infested are calculated by acres mapped multiplied by the percent cover in areas greater than or equal to 0.5 acres. If under 0.5 acres, acres mapped is counted as 100%. Acres treated are calculated by taking the acres infested that were labeled as treated and applying the percent of the infestation treated.

Table 2: Invasive plant species observed in and around Kenai Fjords National Park.

Key To Symbols:
Species present in 2013
O: Species present in 2012, not detected in 2013
H: Species historically present, not detected in 2013
* : Newly detected infestation in 2013

X:

Key To Symbols: Species present in 2013 O: Species present in 2012, not detected in 2013 H: Species historically present, not detected in 2013 * : Newly detected infestation in 2013			X:	Exit Glacier Area											Seward		Coastal Areas						
				Herman Leier Road	Campground	Employee Housing	Exit Glacier Parking Lot	Nature Center Plaza	Main Trail	Trail to the Glacier View	Trail to the Edge of the Glacier	Harding Icefield Trail	Nike Stripe	Outwash Plain	Maintenance Facilities	Information Center	Aialik Bay Public Use Cabin	Kenai Fjords Glacier Lodge Kayak-beach	Holgate Public Use Cabin	Abra Cove Camping Beach	Beauty Bay	North Arm of Nuka Bay	Dinglestad Glacier
Species																							
Latin Name	Common Name	AKEPIC ranking																					
<i>Alopecurus pratensis</i>	meadow foxtail	52	X*					H															
<i>Capsella bursa-pastoris</i>	shepherd's purse	40											X	X									
<i>Cerastium fontanum</i>	mouse-ear chickweed	36			O	O	X	X			O			X									
<i>Crepis tectorum</i>	narrowleaf hawksbeard	56	H																				
<i>Hordeum jubatum</i>	foxtail barley	63				H		H															
<i>Leucanthemum vulgare</i>	oxeye daisy	61	H		H	H																	
<i>Linaria vulgaris</i>	yellow toadflax	69	H			H								X									
<i>Matricaria discoidea</i>	pineapple weed	32	O	X	O	X	X	X		O				X	X		X						
<i>Phleum pratense</i>	common timothy	54	O			X	X	H		H					X				H				
<i>Plantago major</i>	common plantain	44	X	X	X	X	X	X	X	X	X			X	X		X		X*				
<i>Poa annua</i>	annual bluegrass	46	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X*				
<i>Polygonum aviculare</i>	prostrate knotweed	45												X*									
<i>Rumex acetosella</i>	common sheep sorrel	51				O									X								
<i>Rumex crispus</i>	curly dock	48	H		X											O							
<i>Stellaria media</i>	common chickweed	42												X									
<i>Taraxacum officinale</i>	common dandelion	58	X	X	X	X	X	X	X	X	X	X	X	X	X					O	X*	X	
<i>Trifolium hybridum</i>	alsike clover	57	H			H																	
<i>Trifolium pratense</i>	red clover	53	H			H																	
<i>Trifolium repens</i>	white clover	59	X			X	O	H		O				H	X								

Exit Glacier Area

The Exit Glacier area continues to be the focal point of invasive plant management in KEFJ. It is the most heavily used and accessible natural area in the park which makes it particularly vulnerable to the introduction of invasive species. Despite its accessibility and frequent visitation, to date very few high priority species have been documented within the park boundary (Kriedeman 2004). Of the species that have infested NPS land the majority are found in disturbed sites adjacent to the road and trail system, although surveys over the past ten years have shown an increase in invasive plant populations in backcountry areas such as the outwash plain.

Herman Leirer Road

Formerly known as Exit Glacier Road, Herman Leirer Road stretches approximately eight miles from its intersection with the Seward Highway to the KEFJ parking lot at Exit Glacier. This road acts as the primary conduit by which exotic plants, found in Seward or along the Seward Highway, spread to heavily used park lands in the Exit Glacier Area. In its first seven miles the Herman Leirer Road crosses private land, State of Alaska Department of Natural Resources (DNR) land, and Chugach National Forest land before reaching the park boundary at the Resurrection River Bridge. The final 1.3 miles of the Herman Leirer Road within the park boundary have been a focal point of survey and control work for the KEFJ EPMT since the program's inception in 2004.

The margins of Herman Leirer Road host one of the largest and most dense infestations of common dandelion found in KEFJ (Figure 2). In total this infestation accounted for 1.38 infested acres, which was approximately 41% of all infested acres mapped in the park in 2013. The dandelions along Herman Leirer Road have been mapped annually since 2004 and have shown very little change in density and extent over that time period, despite various control attempts (Bauder and Heys 2005). In an effort to curb the spread of this infestation EPMT staff spent three days in late June and early July removing all of dandelion flowers found along the road, amounting in 208 pounds of flower heads. Between August 5th and August 7th two EPMT staff members, with assistance from a six person Southeast Alaska Guidance Association (SAGA) crew, attempted to push the infestation of common dandelion back from the Exit Glacier parking lot. After devoting nearly 100 person hours to hand pulling this infestation approximately 400 linear feet of road side were fully controlled, which equated to 0.12 infested acres or roughly 9% of the total infestation. At this rate it would have taken this crew approximately 18 days (1150 person hours) to control the entire infestation.



Figure 2: Dense stands of common dandelion found along Herman Leirer Road

Meadow foxtail was documented for the first time on Herman Leirer Road in 2013. This was only the second documented occurrence of this grass in the park, which was last documented on

the Main Trail in 2010. The grass was detected during early season surveys on July 2nd, at which time samples were collected and used to verify the plants identification. On July 15th EPMT staff thoroughly surveyed both sides of the Herman Leirer Road finding and controlling a total of ten individual clumps of meadow foxtail in the .25 mile stretch of road between the 1815 moraine sign and the NPS campground.

A large patch of common plantain (*Plantago major*) was documented and controlled in the gravel margin next to the 1889 moraine sign. This patch of plantain has been found in the same location since 2010 but appears to have reduced in size and density with repeated control. White clover (*Trifolium repens*) was documented in two locations along the Herman Leirer Road in 2013. A dense patch of white clover, covering approximately 130 square feet, was found growing in a bed of moss and other native species at the bottom of a drainage ditch on the south side of the road. This was the first time white clover has been documented at this site since 2010 and the infestation had become large and entangled with the native vegetation (Figure 3). The infestation was treated in June but had to be retreated in August as it was found to have fully reemerged. The second patch of white clover consisted of a single plant found and controlled just east of the campground entrance.



Figure 3: White clover found growing along the Herman Leirer Road.



Figure 4: Road construction along Herman Leirer Road

Flooding at the eastern end of Herman Leirer Road has occurred annually since 2009, causing significant road damage and preventing access to the Exit Glacier area. In an effort to help alleviate the damages associated with these flooding issues the margins of the road were completely dug out and replaced with compacted fill which was further armored with large rip rap and concrete Jersey barriers (Figure 4). The majority of road work occurred between April and July 2013 and affected the portion of road extending .5 miles west from the KEFJ entrance sign pull out. This construction has had a significant impact on

the dynamics of invasive plant control along the Herman Leirer Road. In past years this area has hosted a great a number of high priority species including; common timothy (*Phleum pretense*) and white clover last documented here in 2012, Yellow toadflax (*Linaria vulgaris*) last documented in 2011, red clover (*Trifolium pretense*) last documented here in 2009, oxeye daisy

(*Leucanthemum vulgare*) and alsike clover (*Trifolium hybridum*) last documented here in 2008. The soil which once held these infestations was removed and the areas where these species were once documented are now buried under several feet of fresh gravel and rock. In theory, this construction has effectively removed these infestations from this area, but at the same time it has created a large area of freshly disturbed ground which is now at risk of being colonized by other non-native plant species. The construction area was surveyed in July and again August and several common dandelions were already found recolonizing the area.

Exit Glacier Parking Lot

The Exit Glacier Parking Lot was surveyed frequently throughout the 2013 field season. Common dandelion remained the most abundant invasive species in the parking lot. With repeated control efforts, starting in early June and going through mid-August, the EPMT staff was able to treat 95-100% of common dandelions found in this area. A total of 0.10 acres of common dandelion were controlled in the parking lot in 2013, which was a marked reduction in extent from 2012. Common plantain, annual bluegrass and pineapple weed were found and controlled intermittently throughout the parking lot, but were documented at particularly high densities along the far western margin of the parking. On July 31st EPMT staff along with the SAGA crew controlled this infestation removing 71 pounds of annual bluegrass, common plantain and pineapple weed. Three clumps of common timothy (Figure 5) and seven small patches of white clover were found and controlled around the margins of the parking lot in 2013. This marked a slight increase from 2012 when only a single common timothy clump and five white clover patches were documented. The small patch of common sheep sorrel (*Rumex acetosella*) observed along the north side of the parking lot near the bus pullout in 2012, was not detected in 2013.



Figure 5: Alpine timothy (*Phleum alpinum*), seen here on the right, is a common native species found in the Exit Glacier parking lot, which can be confused with its exotic counterpart common timothy seen here on the left.

Campground

The campground, located approximately one mile west of the Resurrection River Bridge on Herman Leirer Road, was monitored monthly throughout the summer in coordination with surveys of Herman Leirer Road. The campsites and cooking area remained free of invasive plants in 2013. A single common dandelion was found and controlled at the beginning of the loop trail behind the informational kiosk. Sporadic patches of common dandelion were found and controlled around margins of the campground entrance, parking lot and vault toilets. A patch containing sixteen plantain, nine pineapple weed and roughly 100 square feet of annual bluegrass was controlled in the south western corner of the campground parking lot.

Employee Housing

Very few invasive species were found in the NPS employee housing area in 2013. EPMT staff surveyed this area regularly and documented and controlled all invasive plants when they were

found. One small patch of annual bluegrass as well as three common plantain were found and controlled in front of the propane tanks at the south eastern corner of the parking area. A single dandelion behind the Cottonwood Cabin and six dandelions found in front of the Alder Cabin were found and controlled. The curly dock (*Rumex crispus*) infestation growing along the front deck of the Willow Cabin was not observed in 2012, but returned and was treated in 2013. The trail builders camp, south of the Alder Cabin, remained free of invasive species in 2013. The SNOTEL weather station, located down a small trail behind Cottonwood cabin, was surveyed twice in 2013. The infestation of common dandelion found at the northwest corner of the weather station clearing in 2012 was not detected in 2013.

Nature Center Plaza and Main Trail

The Nature Center plaza and Main Trail were monitored regularly throughout the 2013 field season. Small patches of common dandelion, common plantain, pineapple weed and mouse-ear chickweed (*Cerastium fontanum*) were documented regularly along the margins of the trail and pavilion. All occurrences of these species were treated and mapped when they were observed. A single clump of common timothy was found growing behind informational kiosk in the Nature Center plaza and was removed. Annual bluegrass was documented in small fragmented clumps around the Nature Center, along both sides of the Main Trail and in the gravel pad in front of the pump house. On July 30th and July 31st EPMT staff with assistance from the SAGA crew controlled 100% of the annual bluegrass found in this area. EPMT staff preformed follow up treatments in late August to remove small and isolated patches of annual bluegrass which were reemerging. In total 0.027 infested acres of annual bluegrass were removed from the Nature Center plaza and Main Trail. This marked a 71% decrease in the infested acres of annual bluegrass documented in this area between 2012 (0.095 infested acres) and 2013.

Trail to the Glacier View

The trail to the Glacier View remains relatively free of invasive species despite being one of the most heavily used trails in the park. The majority of invasive species are contained to the trail's entrance near the Pavilion. A total of eleven common dandelions, six common plantain, two pineapple weed and approximately 90 square feet of annual bluegrass were found and controlled around the margins of the trails paved entrance. This marked a notable decrease in the size and density of annual bluegrass found in this area (Figure 6). The patch of common dandelion found on the 1917 moraine in 2012 was not detected in 2013. Past the Pavilion on the gravel section of the trail a total of three common dandelions, five common plantain and four small clumps of annual bluegrass were documented and controlled. The large clearing located between the trail to the Glacier View and the Main Trail was surveyed in 2013 and no invasive species were found.

Trail to the Edge of the Glacier

The largest infestation found on the trail to the Edge of the Glacier is located just off-trail of a switchback on the northern portion of the Edge of Glacier trail loop. This site was surveyed four times in 2013, between June and August, and all invasive species were documented and controlled when they were found. Approximately 40 common dandelions were removed from this area marking a significant reduction in the density of this infestation since 2012. Outside of this infestation, a total of four common plantain and six individual clumps of annual bluegrass were documented and treated along the lower portions of this trail in 2013. The small patches of annual bluegrass documented in recently deglaciated soil near the top of the loop trail in 2011

and 2012, was not detected in 2013. No invasive species were documented on the recently deglaciated upper portion of this trail



Figure 6: Four years of continued control has significantly reduced the density and extent of annual bluegrass along the trail to the Glacier View allowing native grasses to move into the trail margins.

Harding Icefield Trail

The Harding Icefield Trail (HIT) was a focal point for survey and control work in 2013. Three exotic plant species were documented and controlled along the HIT in 2013, accounting for 0.028 infested acres. The total infested acres documented along the HIT dropped by more than half an acre between 2012 (0.62 acres) and 2013 (0.028 acres), largely due to a reduction in the extent of annual bluegrass found along the trail.

A total of 73 dandelions were documented and controlled along the HIT in 2013. Twelve of these were found growing sporadically along the first mile of the trail. The remaining 61 dandelions were contained to one large patch, which persists along a discontinued section of trail, just above the new trail-cut across the cliff at about .25 miles up the trail. This infestation was monitored and controlled regularly throughout the 2013 season to ensure all plants were fully removed before going to seed. The density of this patch has decreased annually with diligent control efforts. With continued efforts it is possible this population could be completely eradicated in the future.

A total of 4 common plantain were documented and controlled along the HIT, which marked a significant decrease in this species numbers from 2012. A large population of common plantain which was found and controlled in 2012 along the discontinued trail below the bridge, had been reduced to a single individual plant in 2013. Despite the general reduction in common plantain along the HIT, one plantain found just above Marmot Meadows marked the furthest extent which this species has been documented along the HIT. New introductions and occurrences of exotic plant species, such as this, occur along the HIT each year, which further validates the need for regular survey and control work.

Annual bluegrass had been documented and controlled along the HIT since 2010. From July 29-30, a SAGA crew (Figure 7) assisted KEFJ EPMT in mapping and controlling all annual bluegrass infestations found along the HIT. During surveys in late August several small and isolated reemerging populations were found and controlled. In total, .027 infested acres of annual bluegrass was removed in 2013. Populations of annual bluegrass were significantly smaller and more fragmented in 2013 than they have been in years prior. Since the initial mapping of annual bluegrass in 2010 (0.49 infested acres) a 45% decrease in the infestations extent has been documented. This suggests that the focused control efforts, which have been conducted since 2010, have been effective at containing and reducing the spread of annual bluegrass along the HIT and should be continued in the future.



Figure 7: EPMT and SAGA crew pose for a photo in Marmot Meadows



Figure 8: EPMT crew member sprays herbicide on a small patch of common dandelion at the Nike Stripe.

Nike Stripe

A patch of common dandelion which is associated with a natural clearing north of Herman Leirer Road, locally referred to as the Nike Stripe, was chemically treated (Figure 8) twice during the 2013 field season, first on June 25th and again on July 23rd. In total, 2.25 gallons of mixed herbicide containing 0.45 ounces of concentrate were applied to all dandelions found over 0.075 infested acres. With continued control it is hoped that this infestation can be eradicated in the future. Scattered patches of common dandelions were observed, mapped, and sprayed en route to the primary infestation accounting

for an additional 0.003 infested acres.

Outwash Plain

The largest infestations of common dandelion found in KEFJ are located on the south side of Exit Creek in the early successional community known as the Exit Glacier outwash plain. This infestation was first reported in 2002, and initial documentation and control efforts were conducted in 2006 (Bryden 2002) (Wetherbee 2006). As survey efforts in this area increased between 2007 and 2010 the scope of this infestation was discovered to be significantly larger and more widespread than previously recorded (Kurtz 2010). Manual control efforts were stymied due to the logistical difficulty of crossing Exit Creek to reach these infestations. Therefore the

infestations on the outwash plain were chemically controlled in 2011 and 2012, to reduce the time required and improve the treatments overall efficacy.

In 2013 EPMT staff planned to chemically control this infestation over the course of four days from June 17-20, but high waters in Exit Creek and inclement weather cut the treatment window to only two day. On June 18th and June 20th four members of the KEFJ EPMT along with two members of the Alaska Regional EPMT were able to cross Exit Creek to chemically control the infestation of common dandelion on the outwash plain (Figure 9). All sites treated in 2012 and 2011 were revisited and retreated in 2013. In total 28 gallons of mixed herbicide containing 5.6 ounces of concentrate were applied to all common dandelions over a 4.5 acre area. This marked a slight reduction from the gross acreage treated in 2012 (4.8 acres treated). This decline in gross acreage can be attributed to the overall reduction in the size and density of dandelion populations found at the northern extent of the infestation closest to exit creek.



Figure 9: NPS staff spray common dandelion on the outwash plain.



Figure 10: Crew members cross Exit Creek during the 2013 scouting surveys on the outwash plain.

For the third year in a row unforeseen environmental constraints prevented EPMT staff from controlling outlying infestations at the far eastern and southwestern extents of this infestation. Scouting surveys preformed on June 11th confirmed that both of these infestations, last documented in 2010, were still present (Figure 10). Populations of common dandelion at the eastern extent had been reduced in size as a result of scouring during the floods in 2012, while the populations at the southwestern extent was found to occupy approximately the same extent it did when it was originally mapped in 2010.

New Survey Sites

The lowland area south of Herman Leirer Road and north of the Resurrection River was surveyed for the first time by the KEFJ EPMT in 2013. This area was heavily scoured during flooding in the fall of 2012 creating significant disturbance to the native vegetation. Given its close proximity to the extensive infestations of common dandelion on Herman Leirer Road the potential for wind or animal borne seeds to be disseminated into this area was thought to be high. Four EPMT staff members surveyed this area extensively in early June and no invasive species were detected.

Seward

The NPS administers several properties in and around the town of Seward. Though not contained within the park boundary many of these sites act as the main hubs from which NPS employees and equipment depart when traveling into the park. These sites serve as potential sources for the translocation of invasive species and are therefore an important component of the invasive plant management strategy in KEFJ.

Maintenance Facilities

Survey and control work at the NPS maintenance facilities was conducted on a monthly basis during the 2013 field season. Patches of common chickweed (*Stellaria media*), annual bluegrass, common dandelion, pineapple weed and common plantain were found and controlled around the edges of buildings and in the gravel margins throughout maintenance facilities accounting for 0.09 infested acres. Small patches of prostrate knotweed (*Polygonum aviculare*) and shepherd's purse (*Capsella bursa-pastoris*), both documented for the first time in 2012, were found and controlled again in 2013 in the northeast corner of the maintenance facility. A notable infestation of common chickweed, found occupying approximately 1500 square feet along the western edge of the maintenance facilities, was controlled throughout the season using multiple techniques including raking, shoveling and eventually hand pulling with the SAGA crew (Figure 11). The efficacy of these control efforts should be assessed in 2014.



Figure 11: SAGA crew member expresses her feeling about invasive species at the maintenance facilities.

Information Center

The Information Center, located near the Seward Small Boat Harbor, hosts a great diversity of invasive plant species, including the following species documented in 2013; yellow toad flax, pineapple weed, common timothy, common plantain, annual bluegrass, sheep sorrel, common dandelion and white clover. Survey and control work at the Information center was conducted on August 9th and with assistance from the SAGA crew, the EPMT staff was able to remove 100% of invasive plants from this area resulting in over 85 pounds of plant material.

Coastal Areas

In 2013 the KEFJ EPMT was able to survey for and control invasive plants at 15 coastal areas around the park during two multiday boat trips. Sites that were previously determined to have invasive plant infestations were given priority for monitoring and control work, while initial or repeat surveys were conducted as time allowed.

Aialik Bay

Survey and control work in Aialik Bay was conducted off the SAFE Boat from July 8-11. The primary objective of this trip was to control known infestations of annual bluegrass at Aialik and Holgate Public Use Cabins (PUCs). These two populations of annual bluegrass, first documented in 2004 at Holgate PUC and in 2009 at Aialik PUC, are small and contained to areas



Figure 12: NPS staff members identify an unknown dock species on the beach of Aialik PUC

lands owned by the Port Graham Corporation and leased by Alaska Wildland Adventures which operates the Kenai Fjords Glacier Lodge. Therefore, permission must be obtained from staff of the Kenai Fjords Glacier Lodge prior to any control efforts. In 2013 three EPMT staff members surveyed this kayak staging area and found less than ten individual annual bluegrass clumps, four stems of pineapple weed and a single common plantain. This location is also surveyed and controlled by staff from the Kenai Fjords Glacier Lodge, which may account for the limited size of these infestations.

of heavy disturbance associated with the trails around the cabins (Carlson and Lipkin 2004) (Rapp 2009). In 2013 all annual bluegrass at the PUC's was fully controlled by three EPMT crew members, which required less than two hours at each site. The curly dock which had been documented and controlled at Aialik PUC since 2010 was not detected in 2013 (Figure 12).

Infestations of annual bluegrass, common plantain and pineapple weed have been documented at the Kenai Fjords Glacier Lodge kayak staging area on the beach outside Pedersen Lagoon since 2011. These infestations are not on NPS administered lands, but rather on

With the remaining time EPMT staff was able to survey for invasive species at seven additional sites around Aialik Bay. During surveys at Bear Cove, Aialik Bay Ranger Station, the beach north of Aialik Bay Ranger Station, Quicksand Cove, McMullen Cove and Verdant Cove, no invasive species were detected. One small infestation of common plantain and annual bluegrass at the camping beach in Abra Cove was documented and controlled (Figure 13). This infestation consisted of two plantain found in a tent depression as well as approximately 60 square feet of annual bluegrass associated with tent sites and social trails leading to a food storage locker. This is the first documented occurrence of invasive species in Abra Cove, which was last surveyed in 2007.



Figure 13: Crew members disembark to survey the camping beach in Abra Cove in Aialik Bay.

McCarty Fjord

Survey and control work in McCarty Fjord was conducted off the M/V Serac on July 18th. The only population of invasive species currently documented in McCarty Fjord is a small infestation of common dandelion scattered over the rocky outcrops and cliffs south of the terminus of Dinglestadt Glacier. Despite its limited extent, only 329 square feet (0.0075 acres) as of 2013, it remains the largest coastal infestation in KEFJ. This infestation was first documented in 2006 and has been monitored and controlled annually since its discovery. Despite seven years of continued manual control efforts, this infestation has shown no significant reduction in size or density and new occurrences have been documented every year since 2010. Due to the logistical difficulty of getting to these infestations as well as the limited success of manual control work, herbicide treatment was determined to be the most effective and efficient means of control in 2013. On July 18th, EPMT staff along with the Alaska Region EPMT Liaison spot sprayed all dandelion found in the area (Figure 14); with the exception of one particularly hard to reach infestation found growing on the face of a 50-plus foot vertical cliff. This was the first herbicide operation conducted in the coastal areas of KEFJ. In total 2.5 gallons of mixed herbicide containing 0.5 ounces of concentrate were applied to approximately 100 dandelions over 0.083 infested acres.



Figure 14: SCA Intern Nara McCray maps a patch of common dandelion near Dinglestadt Glacier in McCarty Fjord.

Nuka Bay

Survey and control work in Nuka Bay was conducted off the M/V Serac from July 16-17. Surveys were conducted on July 16th at the abandoned Glass-Heifner mine airstrip in Beauty Bay where common timothy has been documented and controlled since 2007 and a single common dandelion was documented and controlled in 2012 (Figure 15). No invasive species were found at this site in 2013, but it should remain a priority for monitoring in the future to ensure these infestations do not reemerge.

Accompanying other RM staff conducting



Figure 15: NPS Bio. Tech. Peter Frank determines the location of a previously mapped infestation in Beauty Bay.

field work in North Arm in Nuka Bay, the EPMT crew was able to conduct three additional surveys at the following sites; Rosness-Larson mine site, Pilot Harbor and the beach at the head of North Arm. During these surveys a small patch of common dandelion was found growing amongst a dense stand of beach wildrye (*Leymus molis*) on the beach berm at the eastern side of the beach at the head of North Arm. This patch, consisting of fewer than 50 dandelions spread sparsely over approximately 650 square feet, was controlled by three EPMT staff members on July 17th. This was the first documented occurrence of invasive species on the beach at the head of North Arm, which was last surveyed in 2007. No invasive species were documented at the Rosness-Larson mine site or in Pilot Harbor.

Outreach and Education

Efforts to educate the park staff, visitors and the general public about the presence and impacts of invasive plants in KEFJ were emphasized during the 2013 season. The EPMT's educational resources, including the parks invasive species informational sheet and invasive plants webpage on the KEFJ website were updated with new park specific pictures and improved content in 2013. EPMT staff members also published three blog posts in the KEFJ RM blog and one article in the web-based newspaper Seward City News, which detailed activities associated with invasive plant management in KEFJ and why they are important to the parks overall goals. EPMT staff met with three visiting trail crews to discuss how the introductions of invasive species during trail maintenance can be successfully mitigated through responsible trail building and maintenance practices. A pamphlet was also developed which outlines best management practices for mitigating the spread of invasive plants during trail work.

To promote awareness and prevent the spread of invasive species within the park, a boot brush station, which consisted of a boot brush and an associated interpretative sign, was installed under the covered entrance to the Exit Glacier Nature Center. This boot brush station was first installed in 2011 and has allowed visitors and staff to clean dirt, potentially laden with invasive plant seeds, from their boots before hiking further onto the Exit Glacier areas trail system.



Figure 16: Volunteers pose for a group photo during the 2013 Herman Leirer Road community weed pull.

Every year in coordination with Alaska Invasive Weed Awareness Week, KEFJ EPMT partners with the Chugach National Forest, Resurrection Bay Conservation Alliance and Alaska Association of Conservation Districts to host the Herman Leirer Road community weed pull (Figure 16). Working together at a number of sites along Herman Leirer Road, volunteers in 2013 succeeded in removing oxeye daisy (*Leucanthemum vulgare*) from the Forest Service pull-out just east of the National Park boundary, significant amounts of alfalfa (*Medicago sativa*) from the Exit Glacier viewpoint, the lone infestation of bird vetch (*Vicia cracca*) at the Forest

Service entrance pull-out, and significant amounts of common dandelion from the entrance to the Resurrection River Trail. A total of 20 people volunteered for five hours and controlled 53

pounds of invasive plants. This effort allowed KEFJ EPMT staff to understand and assist with local invasive plant management outside the park, strengthen bonds with local agencies and organizations, and work toward the prevention of new introductions into the park.

Gypsy Moth Monitoring

In accordance with the Alaska EPMT's early detection and rapid response strategy, a gypsy moth monitoring program was incorporated into the KEFJ EPMT's annual monitoring efforts. The 2013 season marked the third summer that KEFJ staff has participated in the Alaska Division of Agriculture's gypsy moth monitoring program. Current monitoring efforts target European and Asian gypsy moths (*Lymantria dispar* & *Lymantria dispar* spp. *japonica*). A total of five traps were placed around the Exit Glacier area from mid-June through late August (Figure 17). Four traps were placed around the parking lot at the Exit Glacier Nature Center and one trap was placed at the KEFJ campground parking lot (Appendix D). The placement of these traps was set to coincide with the moths' flight period which, in their native range, is generally between mid- June / mid-July to late August / mid- September.

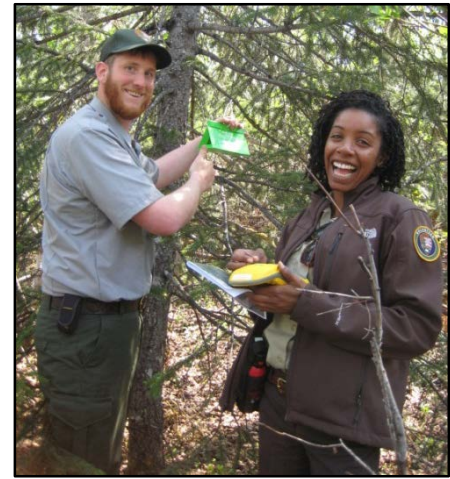


Figure 17: EPMT staff hangs a gypsy moth trap in the Exit Glacier area.

Traps consisted of waxed cardboard trapezoids lined with a sticky coating. A string coated with female gypsy moth pheromones was used to lure adult male moths inside the trap where, in theory, they would be ensnared in the viscid coating that lines the inside of the trap. The traps were checked once a month and data was entered into a GPS for efficient data management.

No gypsy moths were observed in the traps in the Exit Glacier area during the 2013 field season. KEFJ staff should continue to monitor for this nonnative species as part of an early detection and rapid response effort. These monitoring efforts are simple, require little time, and provide park managers with additional information to effectively manage the park.

Discussion & Recommendations

The overall extent and abundance of invasive species found in KEFJ has remained remarkably limited for a park of its size and visitation due largely to the diligence and dedication of the parks EPMT staff over the past decade. Their efforts have laid the groundwork for long term analysis and management of invasive plants in KEFJ. The overall extent and density of invasive species found in the park has been steadily decreasing since 2011, suggesting that persistent monitoring and control efforts are beginning to show signs of effectiveness. In the future the KEFJ EPMT should continue its efforts, incorporating the knowledge gained from the past ten years, to sustain this downward trend in the extent of invasive species. The KEFJ EPMT is in a unique position amongst parks in the Alaska Region as it has the logistical support and manpower to control nearly all of its infestations on a yearly basis. Of the 3.4 infested acres mapped in 2013 only 0.19 acres were not treated, meaning that 94.5% of all invasive plants documented in KEFJ in 2013 were controlled. As the KEFJ EPMT evolves into the future, honing the use of herbicides to quickly and effectively control large infestations and continuing to manually control small infestations should allow for the treatment of virtually all invasive plants found in the park on an annual basis. Invasive plant management is an ongoing process; EPMT staff must remain vigilant for the introduction of new invasive species or the discovery of new infestations. By containing, reducing and potentially eradicating infestations found in the park the EPMT helps to maintain the ecological integrity and natural diversity of KEFJ.

Recommendations for the 2014 KEFJ EPMT center on the prevention and proactive removal of infestations in backcountry and undeveloped frontcountry areas as well as the focused containment of invasive species found in the frontcountry of the Exit Glacier area and along the Herman Leirer Road. Recommended prioritization strategies are, in part, based on gross species acres recorded in 2013 and invasiveness rankings, both of which are summarized in graph form in Appendix B.

Location Specific Recommendations

Exit Glacier Area

Survey work in the Exit Glacier area should remain focused on the trail system and parking lot. These sites should be surveyed on a weekly basis throughout the summer. Surveying and monitoring the progress of areas affected by 2013 road construction should also be a priority in 2014. To help facilitate this sites restoration, KEFJ staff should explore the possibility of reseeding disturbed areas particularly at the western end of the construction area where annual flooding is less severe. The early detection and removal of invasive species colonizing this area will be critical to its restoration. The remainder of the Herman Leirer Road as well as other work areas such as the employee housing area and campground should be surveyed on at least a monthly basis. Meadow foxtail should receive specific attention during survey efforts to ensure it does not remerge along the roadsides.

Manual control efforts should focus on annual bluegrass along the HIT and the lower trail system given the steadily diminishing extent of this species since 2010. Partnering with a SAGA crew in late July and early August to fully control these infestations has proven to be very successful and should be continued in 2014. Control efforts should also focus on controlling all dandelions

found in the parking lot, as dedicated control efforts here since 2004 have resulted in a significant decline in this infestations density and extent. The large patch of white clover found on Herman Leirer Road should also be a target for repeated control and monitoring in 2014. The remaining infestations found in the Exit Glacier area are mostly small and fragmented enough that they can be easily controlled as they are found. Manual control efforts targeted at common dandelion on Herman Leirer Road should be avoided as they have been found to be extremely labor intensive and relatively ineffective.

Herbicide treatments on the outwash plain and at the Nike Strip should continue in 2014. The window for these treatments should be significantly expanded in 2014. The majority of control work should still be performed along with regional EPMT staff over the course of a single week. However, multiple initial and follow up trips should also be made opportunistically as weather and creek conditions permit in order to control small outlying populations which are more difficult to reach with a large crew. The infestation of common dandelions along Herman Leirer Road should also be considered for herbicide treatment in 2014. This is the only major infestation in KEFJ which is not effectively controlled on an annual basis and as such serves as a source population from which seeds can be spread to previously uninfested areas or re-infest previously treated areas, such as the parking lot. The use of herbicide along the road could significantly increase the EPMT's ability to reduce, fragment and eventually contain this infestation.

To date very little work has been done to determine the efficacy of the herbicide treatments performed in KEFJ since 2011. Knowing the efficacy of herbicide treatments will help guide decision making as to the herbicide program at KEFJ develops. Geospatial data collected during treatments suggests that infestations are slowly declining in overall extent from year to year and qualitative assessments from staff members suggest that infestations may be less dense, but no empirical data on efficacy has been collected. Therefore in 2013 a 10x10 foot plot was established in one of the larger populations of common dandelion found on the outwash plain to help quantitatively assess the efficacy of chemical treatments. The plot was delineated with flagging and mapped. During control efforts on June 18th 142 dandelions were counted within this plot and were controlled with herbicide. The number of dandelions found in this plot should be counted in 2014 to determine the efficacy of treatment at this plot. These methods are a very rudimentary means to assess efficacy and therefore efforts should be made in 2014 to bolster the study of herbicide efficacy in KEFJ. This could entail better delineating the current test plot, establishing additional plots in new locations or testing different concentrations or formulations of herbicide.

A small patch of an unknown rhizomatous grass was detected on the Herman Leirer Road in front of the 1815 moraine sign during survey work conducted in mid-July. The grass was initially suspected to be smooth brome (*Bromus inermis*) a highly invasive grass, which has been documented outside the park on Herman Leirer Road (AKEPIC 2013). Positive identification could not be made on this grass without an inflorescence, but unfortunately no inflorescences were seen during the 2013 field season. This grass should be closely monitored in 2014. EPMT staff should coordinate with maintenance staff to ensure the area around the 1815 moraine sign is not brushed, which usually occurs each year in early to mid-July. If this species is positively identified as smooth brome it should be aggressively controlled.

Seward

Given the frequent traffic of park staff and vehicles from the maintenance facilities to the park and highly infested areas, such as Seward, the risk of introducing or spreading invasive plant propagules between these locations on gear, vehicles and equipment, is high. The maintenance facility should remain a high priority for monitoring and control in 2014. Through regular control efforts EPMT staff should be able to control all infestations found around the maintenance facilities. New control techniques such as burning or tarping, could be used on the large infestation of common chickweed at the western extent of the maintenance facility in 2014. Manual control efforts in 2013, including hand pulling, raking and shoveling appear to have been only moderately successful in reducing the extent of this infestation.

The Information Center should be treated as a low priority in 2014. If time permits, EPMT staff should explore the possibility of replacing the current non-native species planted in the garden bed at the Information Center with native species, such as western columbine (*Aquilegia formosa*), blue-joint grass (*Calamagrostis canadensis*) and lupine (*Lupinus nootkatensis*). This could be a collaborative effort between interpretation, education and RM staff and seed collected in the park could be cultivated and used in this project.

Coastal Areas

Surveying coastal areas of the park should continue to be a high priority for the KEFJ EPMT in 2014. The documentation of two previously unknown coastal infestations at Abra Cove in Aialik Bay and the beach at the head of North Arm in Nuka Bay highlight the need for frequent and thorough surveys to be performed throughout the coastal regions of KEFJ. The first priority for surveys should be the sites of historic infestations, such as the abandoned Glass-Heifner airstrip in Beauty Bay. The second priority for surveys should be known camping or human use sites as these have the greatest potential invasive plant introductions. New surveys at largely unvisited sites, such as Pilot Harbor or the Rosness-Larson mine site should be conducted opportunistically as time allow. Surveys in the Pedersen Glacier area, including the beach outside Pedersen Lagoon, the Pedersen Lagoon camping easement, and the trail providing access to the upper Pedersen Lagoon from Kenai Fjords Glacier Lodge, should be a priority in 2014. These areas receive heavy visitor use and are therefore highly susceptible to invasive plant introductions. Staff members at the Kenai Fjords Glacier Lodge have been proactive in managing invasive species on their property and have cooperated fully with NPS staff during survey and control work. This is an excellent partnership and it should be sustained in the future.

EPMT staff should once again attempt to control all known coastal infestations in 2014. Priority should be given to chemically re-treating the infestation of common dandelion located next to Dinglestadt Glacier in McCarty Fjord. The infestation of common dandelion at and the beach at the head of North Arm should also be considered for chemical treatment as part of the EPMT's EDRR strategy, given its isolated location in an otherwise pristine habitat. Unfortunately, the majority of common dandelion found next to Dinglestadt Glacier and the beach at the head of North Arm had already gone to seed by mid-July when EPMT staff was able to treat these infestations. Therefore it is suggested that in 2014 a trip to the southern regions of the park be conducted before any trips are made to Aialik Bay. The infestations of annual bluegrass, common plantain and pineapple weed in Aialik Bay typically have a later phenology than common dandelion and therefore could be treated later in the month of July. In previous years, time has allowed for EPMT staff to retreat infestations of annual bluegrass at the PUC's during

their closing in early September. An effort should be made in 2014 to accompany RM and maintenance staff on the PUC closing trip so that this control work can be performed.

Data Collection

In order to make appropriate management decisions for future survey and control work it is crucial that data collected on the extent of invasive species in KEFJ be as accurate as possible. The infestations found in KEFJ are limited enough in extent that it is within the capabilities of the parks EPMT program to very accurately map these infestations on a yearly basis. As infestations become smaller and more fragmented, accurately portraying their geospatial locations becomes increasingly difficult and labor intensive. Though the individuals collecting data for the KEFJ EPMT change on an almost yearly basis, the objective to collect data representing the locations of invasive plants in the most concise and accurate manner feasible remains the same. The 2013 KEFJ EPMT strove to collect data as accurately as possible, which should remain a high priority 2014.

Outreach and Education

Outreach and education pay dividends well beyond the hours spent on it. In a community such as Seward where the infestations which threaten to invade the park far exceed the ability of EPMT staff to control, connections between the park and local or regional stakeholders are vital. Partnerships with the Alaska Association of Conservation Districts (AACD), Resurrection Bay Conservation Association (RBCA), the Chugach National Forest and the Kenai Peninsula Cooperative Weed Management Association (CWMA) should continue in the future as they provide excellent opportunities for the KEFJ EPMT to collaborate on local projects and events. These partnerships also serve as means to share and disseminate information on local weed management issues to the general public.

One such partnership is the Herman Leirer Road community weed pull, which has proved to be an effective way to control the invasive plants that directly threaten to invade KEFJ as well as an excellent venue to increasing park and public awareness to the environmental issues associated with invasive species. As a direct result of the continued annual treatment during the community weed pull, many of the high priority species found on Herman Leirer Road such as oxeye daisy, bird vetch, yellow alfalfa and white sweetclover (*Melilotus albus*) have been significantly reduced in extent. Therefore, EPMT staff in 2014 should once again organize the Herman Leirer Road community weed pull in partnership with the Chugach National Forest, RBCA and AACD. The weed pull should be scheduled in late June to coincide with Alaska Weeds Awareness week.

Knowledge is an essential tool in preventing the spread of invasive plants. EPMT staff should continue to their efforts to educate visitors, volunteer crews and park staff about invasive species and the best ways to prevent their introduction and spread. EPMT staff should continue to present information to KEFJ staff during their preseason training to give them a background on what invasive plant management issues we have in the park. Presentations should also be given to volunteer crews when they first arrive at the park. In 2014 EPMT staff should follow up with maintenance staff and crews after presentations to ensure that crews are following best management practices for invasive plant mitigation. This will be of particular importance for the crew which brushes the road, as their brush cutters are often unwashed and could harbor invasive plant seeds. Various mediums including pamphlets, information sheets, webpages, blogs,

newspaper articles and even Facebook posts were used in 2013 to disseminate information about invasive species a multitude of audiences. The 2014 EPMT staff should continue creating new and unique way to share and educate people about invasive species.

Invasive plant management is a dynamic field, especially in Alaska where new species are introduced regularly and management techniques evolve to meet the needs of our unique environment. Regional invasive species workshops and conferences provide a venue for KEFJ staff to meet other regional stakeholders and discuss broader weed management issues. These gatherings are an important part of the continuing education of the EPMT staff at KEFJ. In 2013 EPMT staff attended the Kenai Peninsula CWMA's Invasive Species Identification Training in order to gain a better understanding of weed management issues occurring on the Kenai Peninsula. In the past EPMT staff members have attended the annual meeting of the Committee for Noxious and Invasive Plants Management in Alaska (CNIPM), to build partnerships and gain knowledge from weed managers beyond the Kenai Peninsula. Future EPMT staff should continue to be active in the regional invasive plant community and attend conferences and workshops whenever possible.

Seed Collection

Restoration is a key element in preventing the establishment and spread of invasive species. Therefore staff members at KEFJ have preemptively begun the process of collecting and storing seed to be used as necessary in future restoration efforts. A list of native plant species whose seed would be viable for restoration and revegetation projects was compiled by KEFJ RM staff, with assistance from experts at the Alaska Plant Materials Center, and was included in the parks Revegetation and Restoration Planning document. Using this list as a guide, a seed bank was started in KEFJ in 2012. Seed collection efforts were continued in 2013 as NPS staff collected seed from the following plants: western columbine (*Aquilegia formosa*), goats beard (*Aruncus dioicus*), blue-joint grass (*Calamagrostis canadensis*), Merten's sedge (*Carex mertensii*), meadow barley (*Hordeum barchyantherum*), lupine (*Lupinum nootkatensis*) and alpine timothy (*Phleum alpinum*). EPMT staff should continue to assist in seed collection efforts in the future and look to expand the quantity of seed collected as well as the diversity of species from which it is collected.

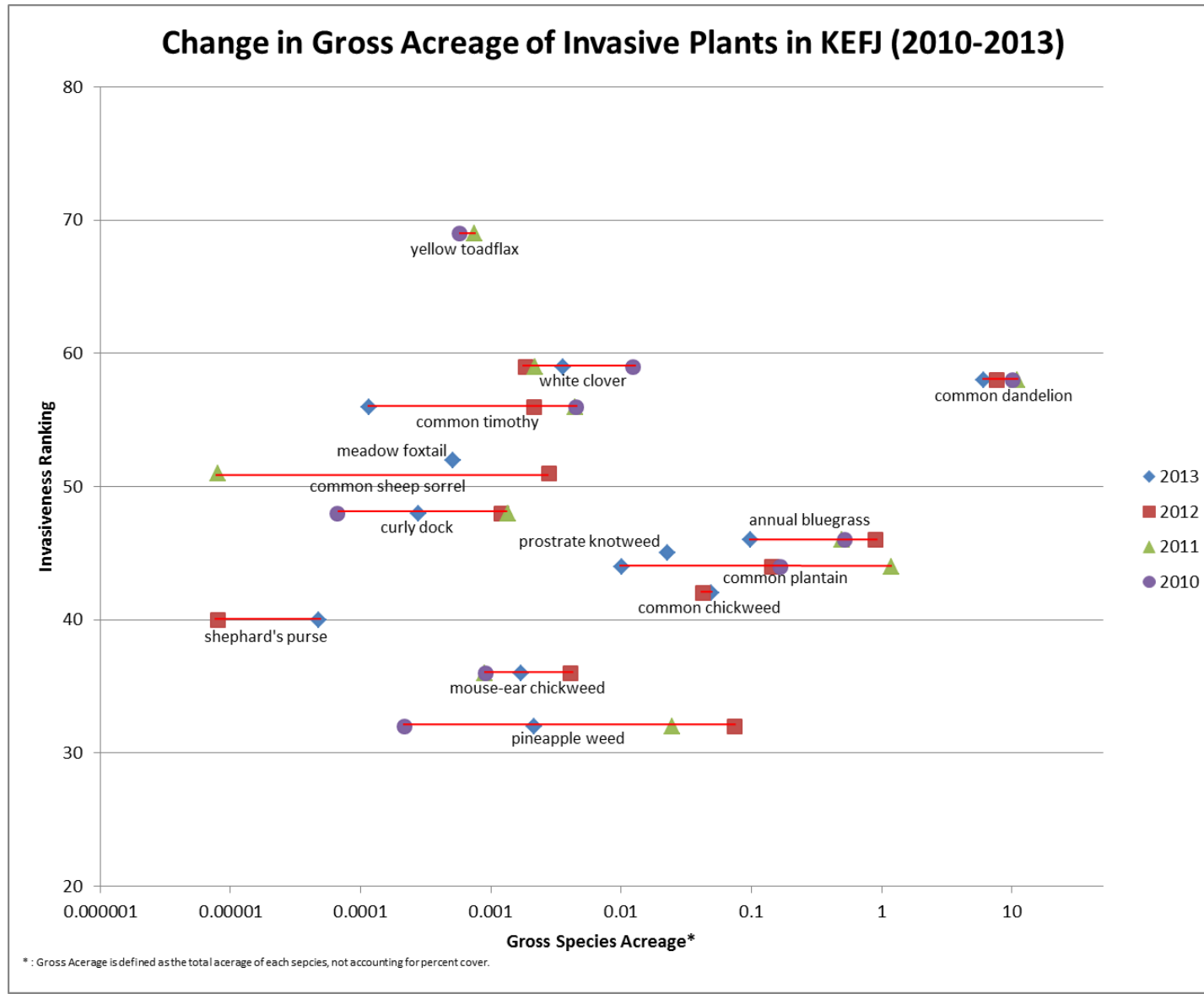
Literature Cited

- Alaska Natural Heritage Program. 2013. *Alaska Non-Native Plant Species List* (<http://aknhp.uaa.alaska.edu/botany/akepic/non-native-plant-species-list/#content>). Alaska Natural Heritage Program, University of Alaska, Anchorage. Accessed (2013).
- Alaska Exotic Plant Information Clearinghouse. 2013. *Alaska Exotic Plant Information Clearinghouse database* (<http://aknhp.uaa.alaska.edu/maps/akepic/>). Alaska Natural Heritage Program, University of Alaska, Anchorage. Accessed (09, 23, 2013).
- Bauder, P. and J. Heys. 2005. *Invasive Plant Manual Control Analysis: Kenai Fjords National Park*. National Park Service Unpublished Report. Anchorage, Alaska.
- Bryden, W. 2002. *Final report: Exotics inventory for Exit Glacier study area, Kenai Fjords National Park, Summer 2002*. National Park Service Unpublished Report, Seward, Alaska.
- Carlson, M. L., R. Lipkin, M. Sturdy, and J. A. Michaelson. 2004. *Kenai Fjords National Park vascular plant inventory final technical report*. Alaska Natural Heritage Program, Anchorage, Alaska.
- Carlson, M. L., I. V. Lapina, M. Shephard, J. S. Conn, R. Densmore, P. Spencer, J. Heys, J. Riley, and J. Nielsen. 2008. *Invasiveness ranking system for non-native plants of Alaska*. USDA Forest Service, R10, R10-TP-143.
- Hulten, E. 1968. *Flora of Alaska and Neighboring Territories*. Stanford University Press, Stanford, California.
- Kriedeman, C. *Final Report: Exotic Plant Management Team 2004*, Kenai Fjords National Park. National Park Service Unpublished Report, Seward, Alaska.
- Kurtz, D. 2010. *Invasive plant management for Kenai Fjords National Park: 2010 Summary report*. Natural Resource Data Series NPS/KEFJ/NRDS—2010/109. National Park Service, Fort Collins, Colorado.
- Million, B., W. Rapp, T. Federal, A. Lain and C. Overbaugh. 2013. *Alaska Exotic Plant Management Team: 2013 Field protocol*. National Park Service Unpublished Report, Anchorage, Alaska.
- National Park Service Alaska Region. 2009. *National Park Service Invasive Plant Management Plan Revised Environmental Assessment*. U.S. Department of the Interior, Alaska Regional Office, Anchorage, Alaska.
- Pojar, J., and A. MacKinnon. 1994. *Plants of the Pacific Northwest Coast*. Lone Pine Publishing, Vancouver, British Columbia.

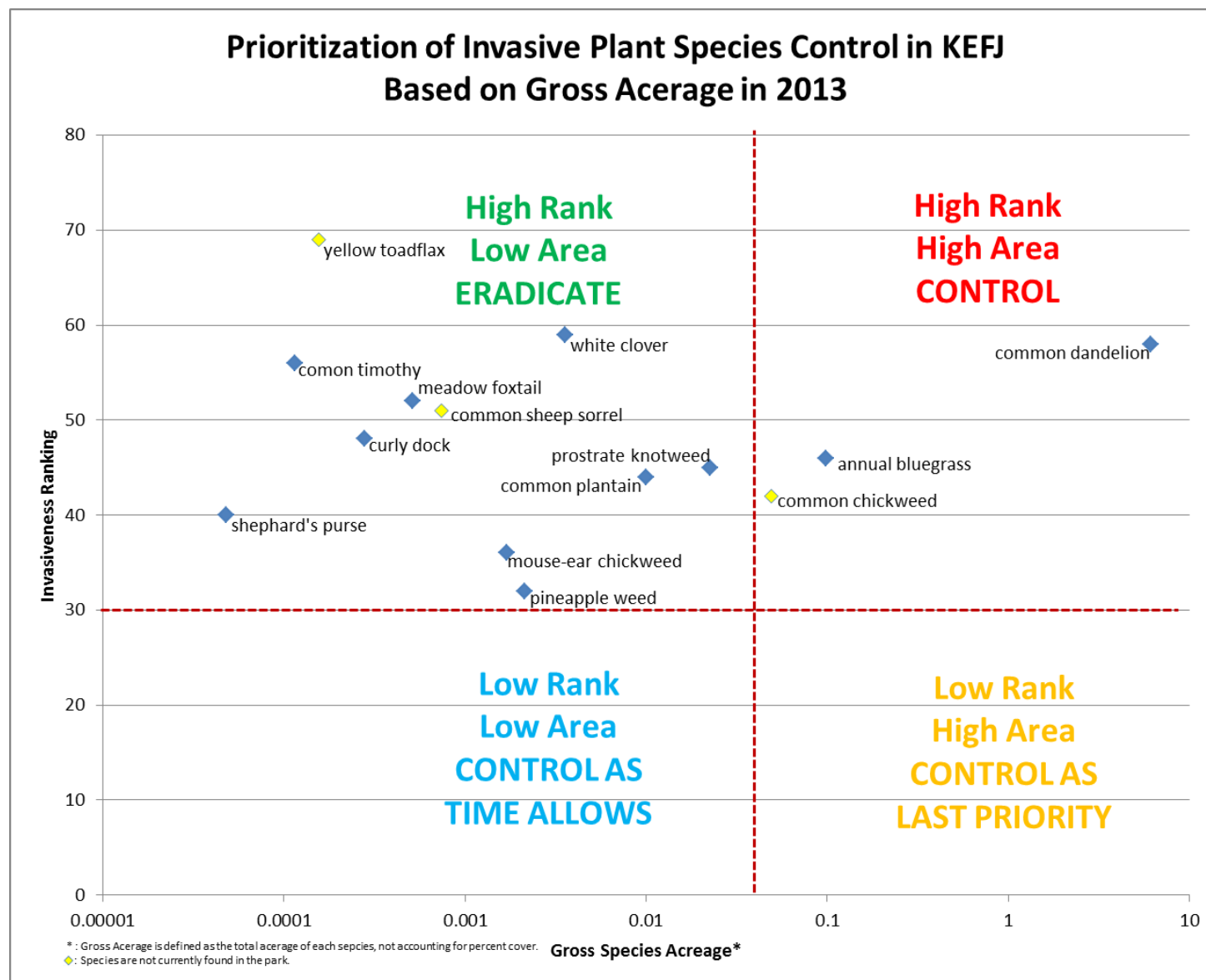
- Rapp, W. 2009. *Invasive species summary for the Southwest Alaska Inventory and Monitoring Network*. Natural Resource Report NPS/SWAN/NRR—2009/152. National Park Service, Fort Collins, Colorado.
- Shaffer, B. J. 2000. *The Flora of South Central Alaska*. University of Alaska Anchorage and Kenai Peninsula College, Soldotna, Alaska.
- Skinner, Q. D., S. J. Wright, R.J. Henszey, J.L. Henszey and S.K. Wyman. 2012. *A Field Guide to Alaska Grasses*. Education Resources Publishing, Cummings, Georgia.
- Wetherbee, H. 2006. *Invasive plant management in Kenai Fjords National Park: Summer 2006 field season report*. National Park Service Unpublished Report, Seward, Alaska.

Appendix A: Change in Gross Acreage of Invasive Plants in KEFJ (2010-2013)

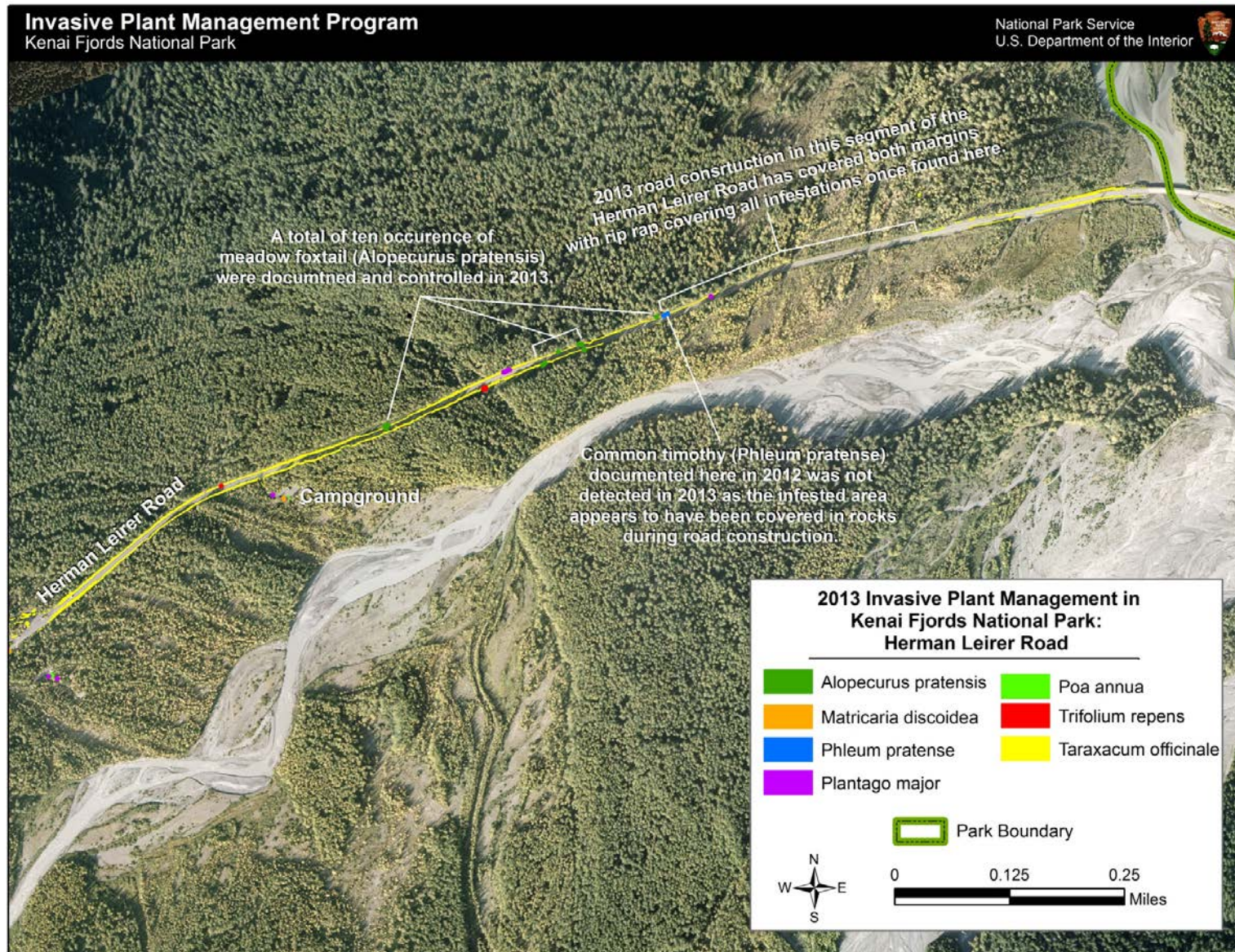
29

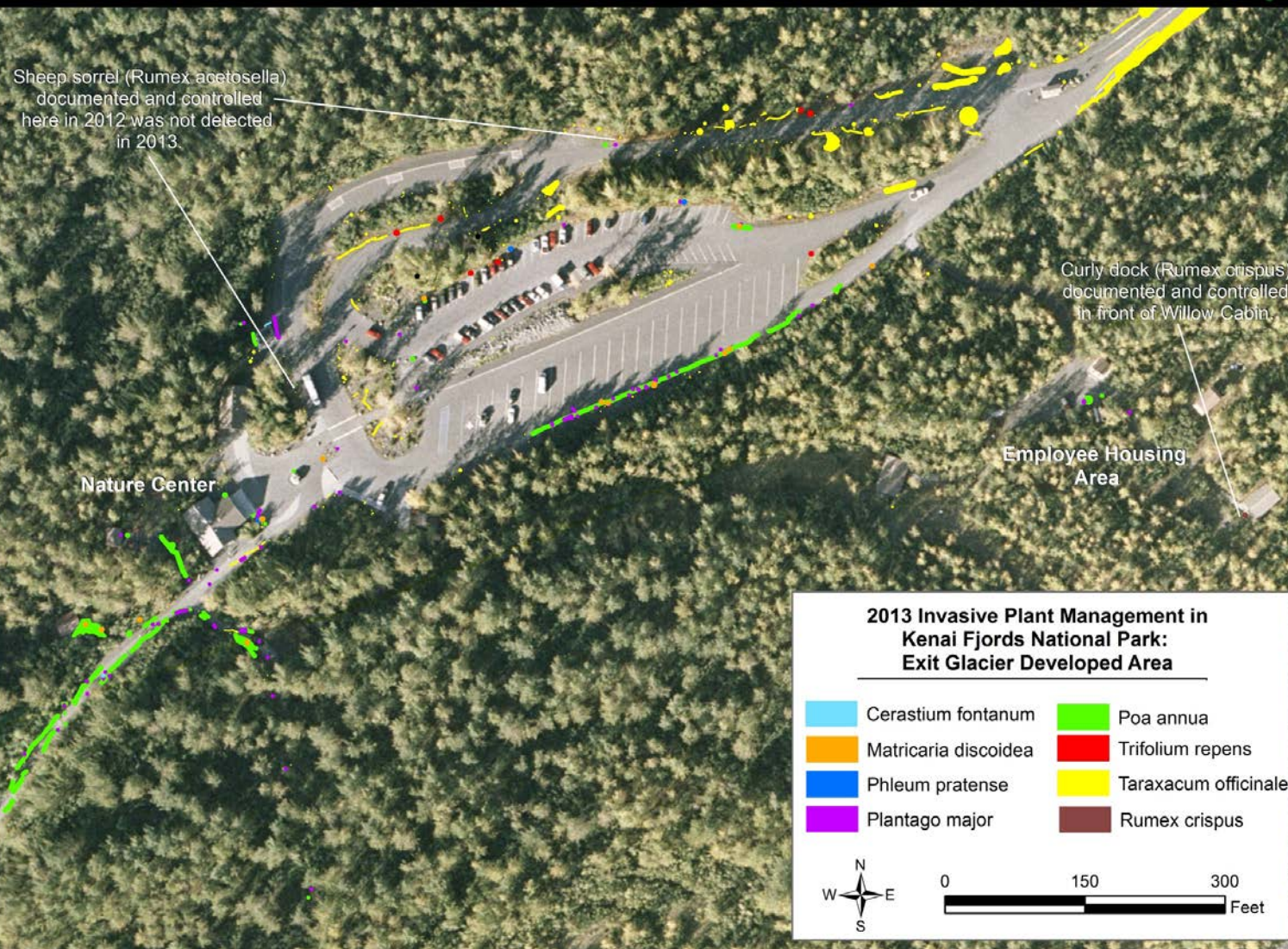


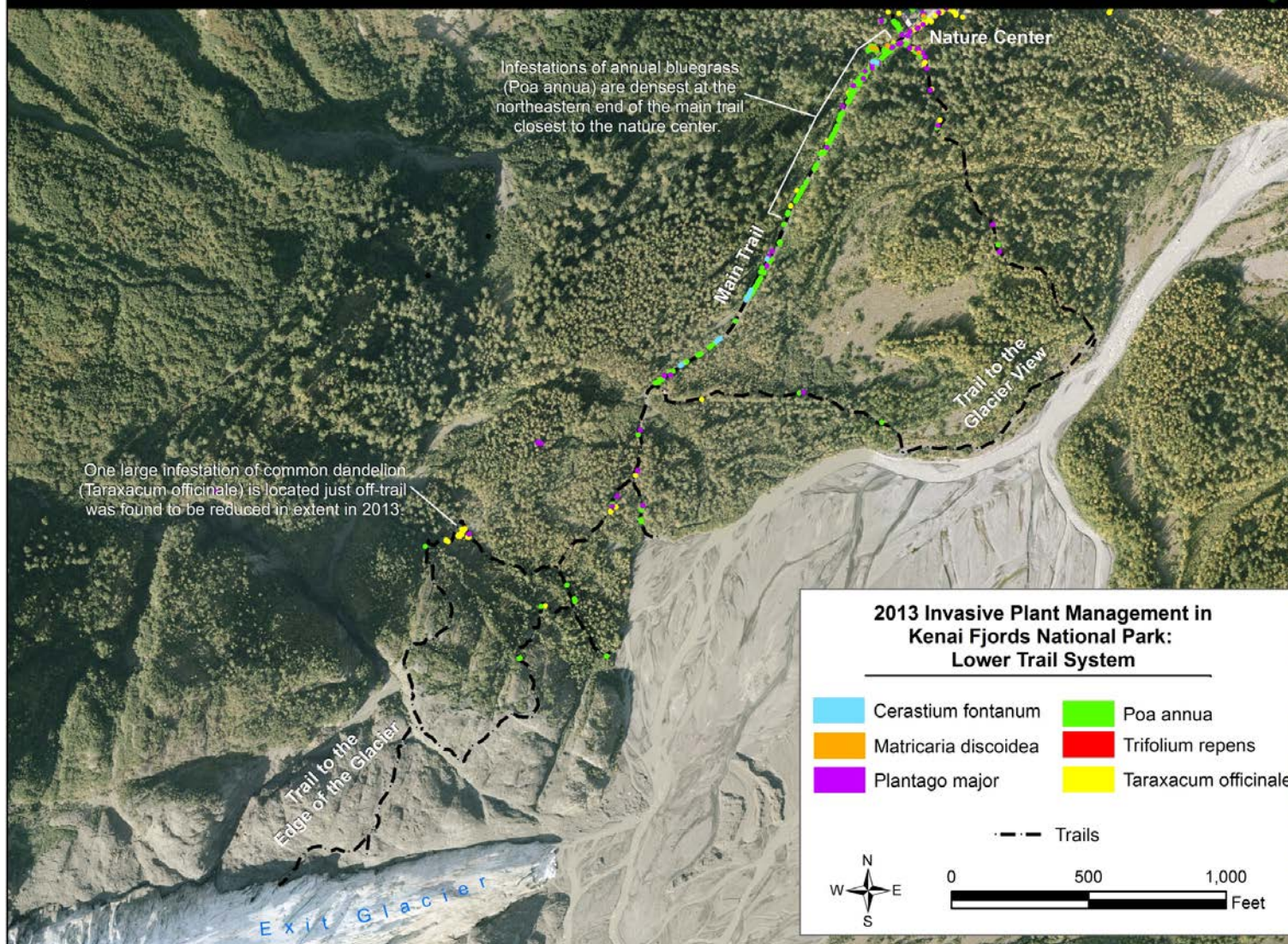
Appendix B: Prioritization of Invasive Species

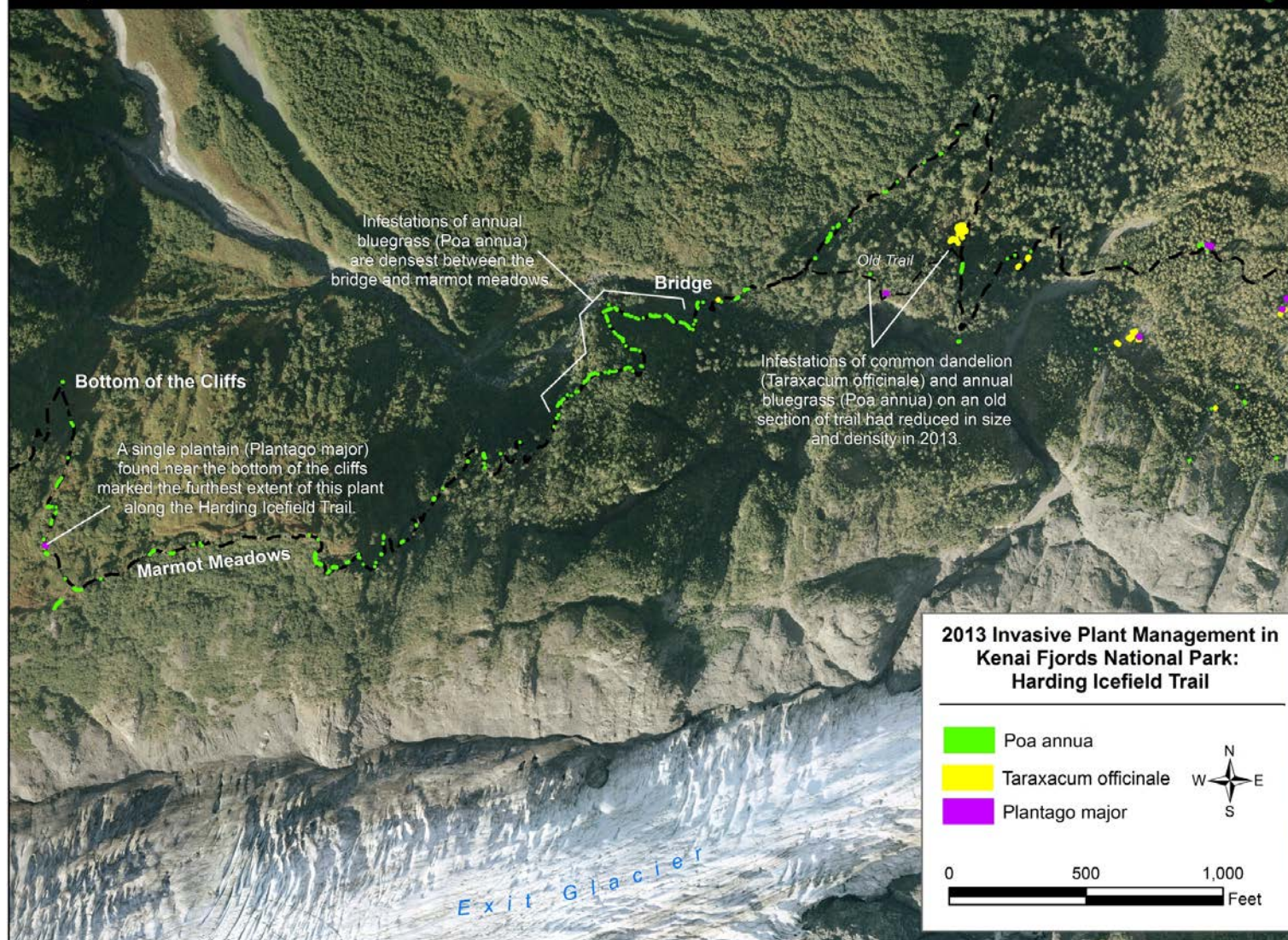


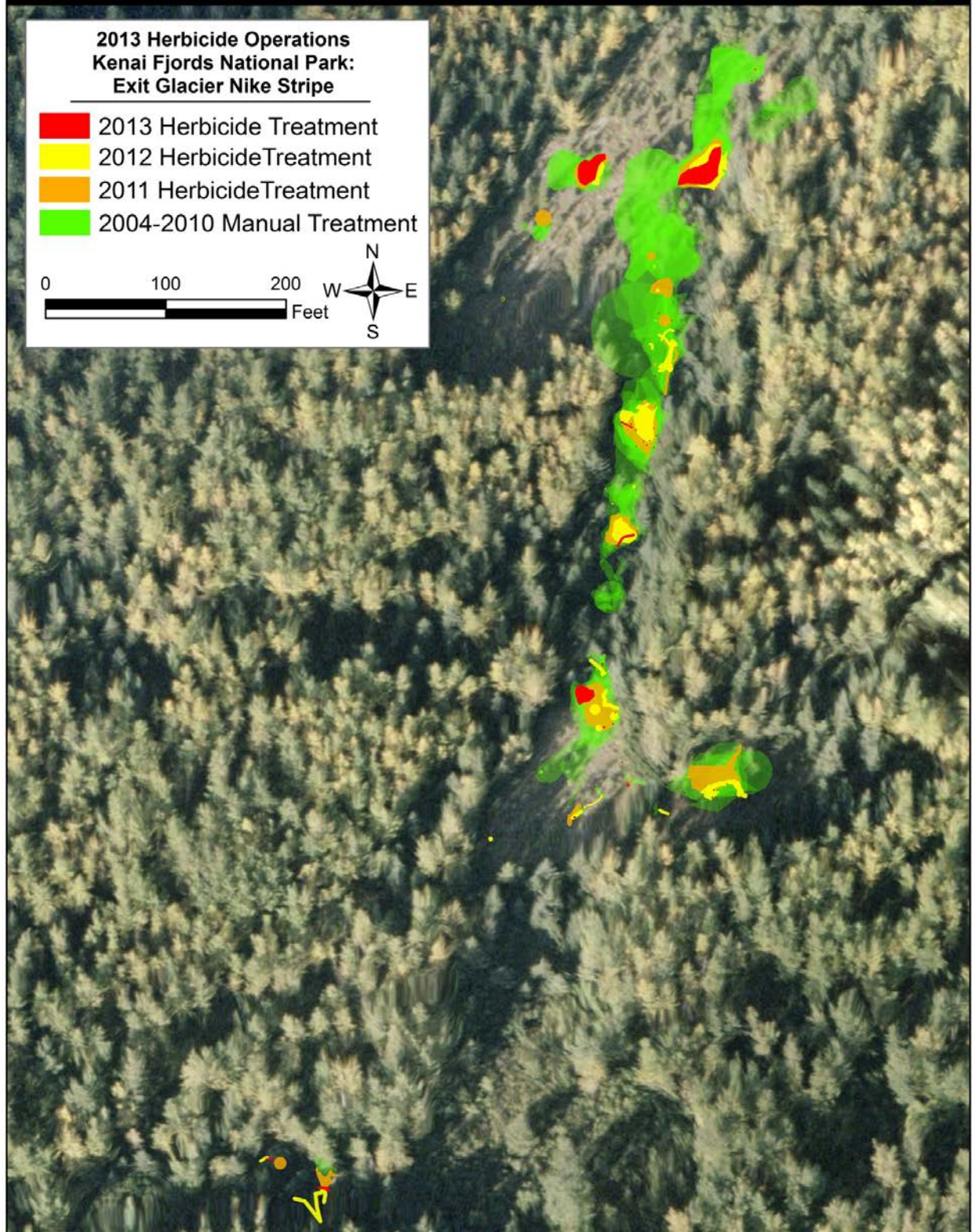
Appendix C: Site Specific Maps

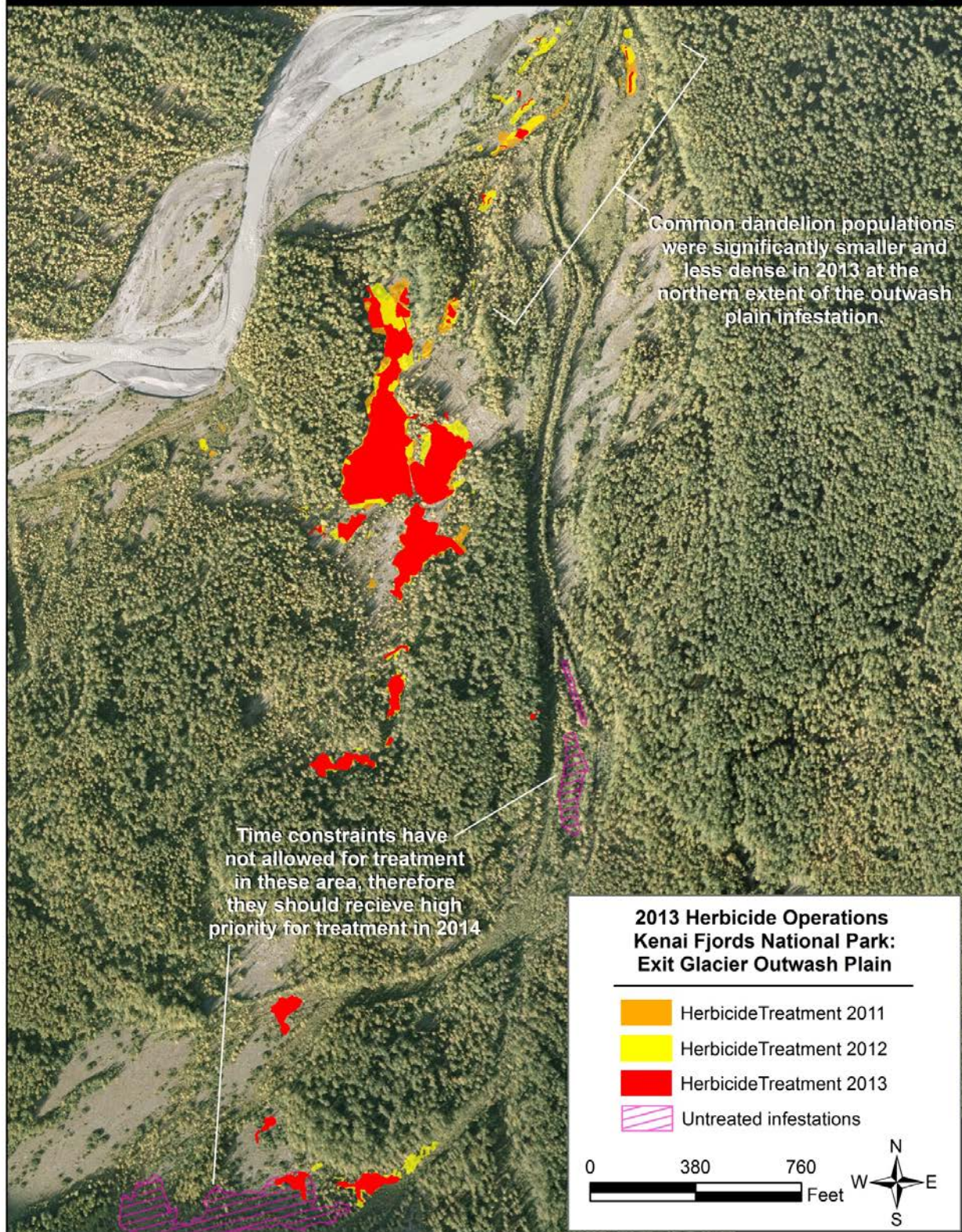














**2013 Invasive Plant Management in
Kenai Fjords National Park:
Maintenance Facility**

	<i>Capsella bursa-pastoris</i>		<i>Stellaria media</i>
	<i>Matricaria discoidea</i>		<i>Polygonum aviculare</i>
	<i>Plantago major</i>		<i>Taraxacum officinale</i>
	<i>Poa annua</i>		



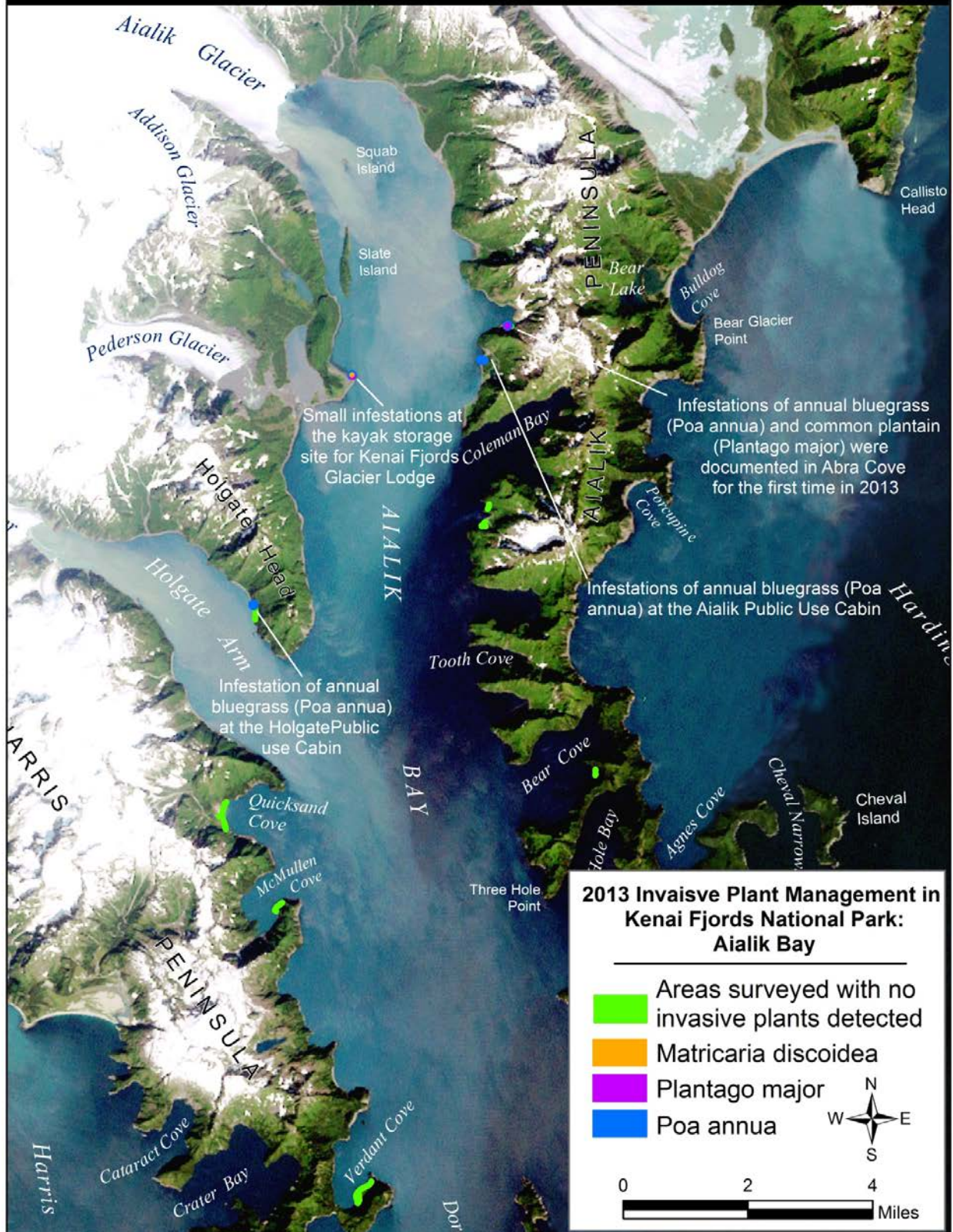
A single occurrence of
Shepherd's purse
(*Capsella bursa-pastoris*)
was documented and
controlled in 2013

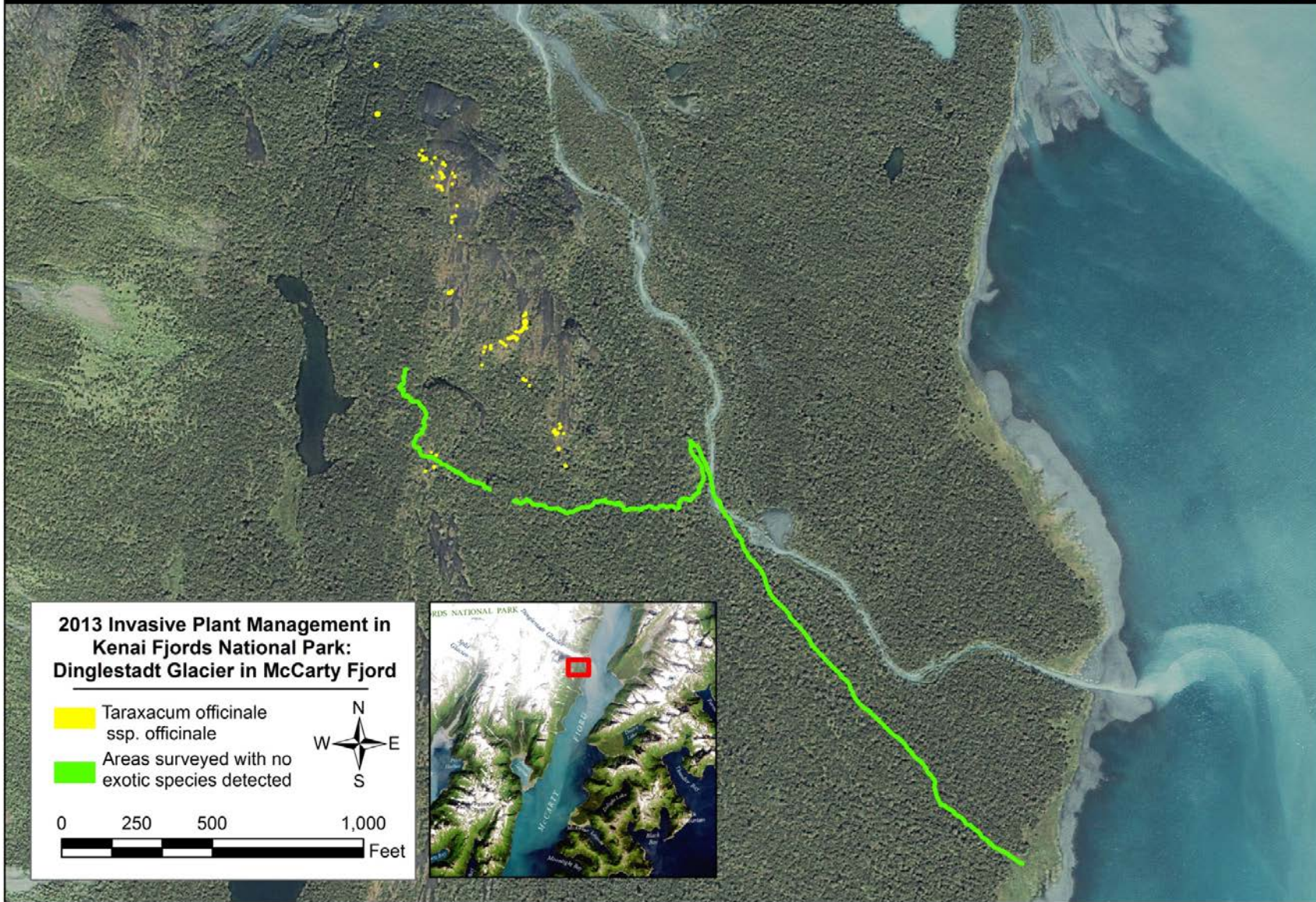
Dense patches of chickweed
(*Stellaria media*) were controlled
with a SAGA crew in August.

Invasive Plant Management Program

Kenai Fjords National Park

National Park Service
U.S. Department of the Interior

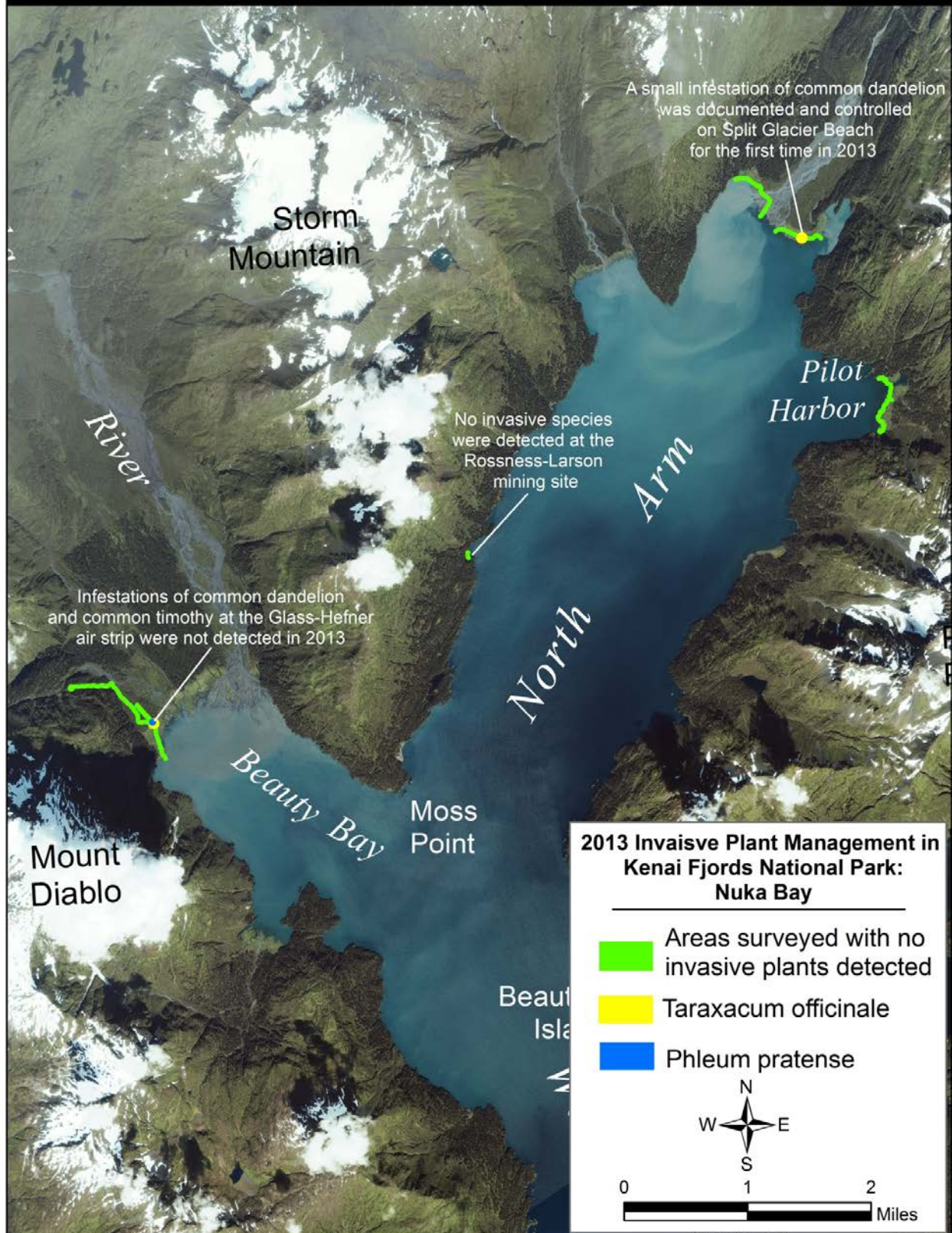




Invasive Plant Management Program

Kenai Fjords National Park

National Park Service
U.S. Department of the Interior



Appendix D: Gypsy Moth Monitoring Trap Locations

